Forest Insect and Disease Conditions in Canada 1988

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Cover: Insect pathology taxonomist M. André Carpentier working on identification of a disease organism (Forestry Canada - Québec Region, courtesy D. Lachance).

Forest Insect and Disease Conditions in Canada 1988

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Introduction

The Forest Insect and Disease Survey (FIDS) is a nationally coordinated program of six regional FIDS units and the FIDS Technology Development Project. Activities are managed by the regional Forestry Canada establishments. The program provides perspectives on insects and disease, including effects of acid rain, to forest managers, quarantine agencies, researchers, educators, and the public. Significant changes are now being made to FIDS through its new Strategic Plan. The FIDS Strategic Plan defines the role of FIDS and its responsibilities in relation to other federal and provincial agencies. It also provides guidance for FIDS program development and activities over the next several years. The levels of provincial and industry involvement and their roles in Forest Insect and Disease Surveys are becoming increasingly diverse. However, there is a need to maintain the capacity to carry out federal mandates.

The proposed strategic direction for FIDS includes:

1) Intelligence gathering: analysis and generation of knowledge, and forecasting and prediction;
2) Identification of federal/provincial survey responsibility;
3) Special surveys and studies: Research, development, and implementation of survey techniques and methodologies;
4) Identification and establishment of the FIDS role in the Plant Quarantine Act and in interprovincial and international marketing relationships.

Forest Insect and Disease Conditions in Canada 1988 is the ninth in a series of national annual reports of the Forest Insect and Disease Survey. In cooperation with those responsible for improving forest inventory and economic data in Canada, the survey is attempting to provide more quantitative and interpretive data on damage and depletion caused by forest pests. The new initiative requires the development of methodologies and procedures before complete and accurate data can be made available. As forest management intensifies and old growth forests are gradually replaced by new, managed forests, new pest problems and impacts will arise and require increased attention (for example, the spruce budmoth). Accordingly, regional and national reporting will continue to be modified to reflect the changing activities and findings of the survey.

This report is produced through a cooperative effort of the six Forestry Canada regional establishments. The Forest Pest Management Project (formerly FIDS Technology Development Project) coordinates technology development for FIDS. Based at the Petawawa National Forestry Institute (PNFI), the project draws on the strength of resident expertise in computing, data analysis, remote sensing, and modeling in support of FIDS activities.

In this report, pests considered to be currently significant in terms of their present or potential economic, sociological, or environmental impact are described in detail under "Major Forest Insects and Diseases". Regional surveys of pest problems in special situations or of specific pests are summarized under "Special Surveys". The status of many other pests is presented in tabular form by region under the title "Other Insects, Diseases, and Damage". Although they do not, in most cases, have spectacular effects, they are important because of their potential for expansion, quarantine considerations, their possible role as vectors, and as indicators of other problems. Additional information on these and other pests can be obtained from regional forestry centers of Forestry Canada.

There are several insidious forest pests in Canada that are not amenable to routine detection surveys and, therefore, escape annual census; nevertheless, they do cause significant losses. This report recognizes the importance of these pests through periodic descriptive, if not quantitative, reviews.

As much as possible in this report we have used current nomenclature and authorship to designate pest species. Because the taxonomy of some species changes occasionally and old names tend to persist, we have striven to realistically balance clear communication to our audience and incorporation of taxonomic revision.

In addition to those already named we would like to acknowledge the field and laboratory staffs of the forest centres, officers of provincial and federal governments and agencies, the forest industry, and private individuals. The ministère de l'Énergie et des Ressources Québec, Service de la protection contre les insectes et les maladies (SPIM) provided most of the information from Québec, except the pinewood nematode survey and balsam fir special survey, which was done through the FIDS unit at the Laurentian Forestry Centre of Forestry Canada. Finally, we thank those who provided us with comments and suggestions on previous reports.

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Coordinator, Forest Insect and Disease Survey

Summary of Defoliation and Damage Estimates

A summary of areas affected in 1988 by major defoliating insects or bark beetles is presented in Table 1 to illustrate the magnitude of the problems. This is done in full realization that strict comparison is not possible: usually a succession of defoliation years is required to kill a tree, and this varies with the pest, the tree species being attacked, and other factors, some of which may be poorly understood. As well, growth losses incurred as a result of pests and the factors influencing these losses are even less well known. Differences in survey methodologies for each pest further complicate comparisons.

Table 1. Selected Major Pests: Comparative estimates of areas of moderate to severe defoliation in 1988 ('000 ha)

Province or territory	Spruce budworm	Jack pine budworm	Mountain pine beetle[a]	Hemlock looper	Forest tent caterpillar	Gypsy moth
Newfoundland	2	-		13		
Prince Edward Island	0	-				
Nova Scotia	0	-				
New Brunswick	500	-				
Québec	434	-			582	
Ontario	5225	737			3965	30
Manitoba	31	0			53	
Saskatchewan	32	0			932	
Alberta	61	0			2766	
Northwest Territories	14	-			-	
British Columbia[b]	36[c]	-	63		52	
Total	6335	737	63	13	8350	30

[a]Areas where beetle-killed trees occurred.
[b]Western spruce budworm caused light to moderate defoliation on an additional 359 670 ha.
[c]Light to moderate defoliation.

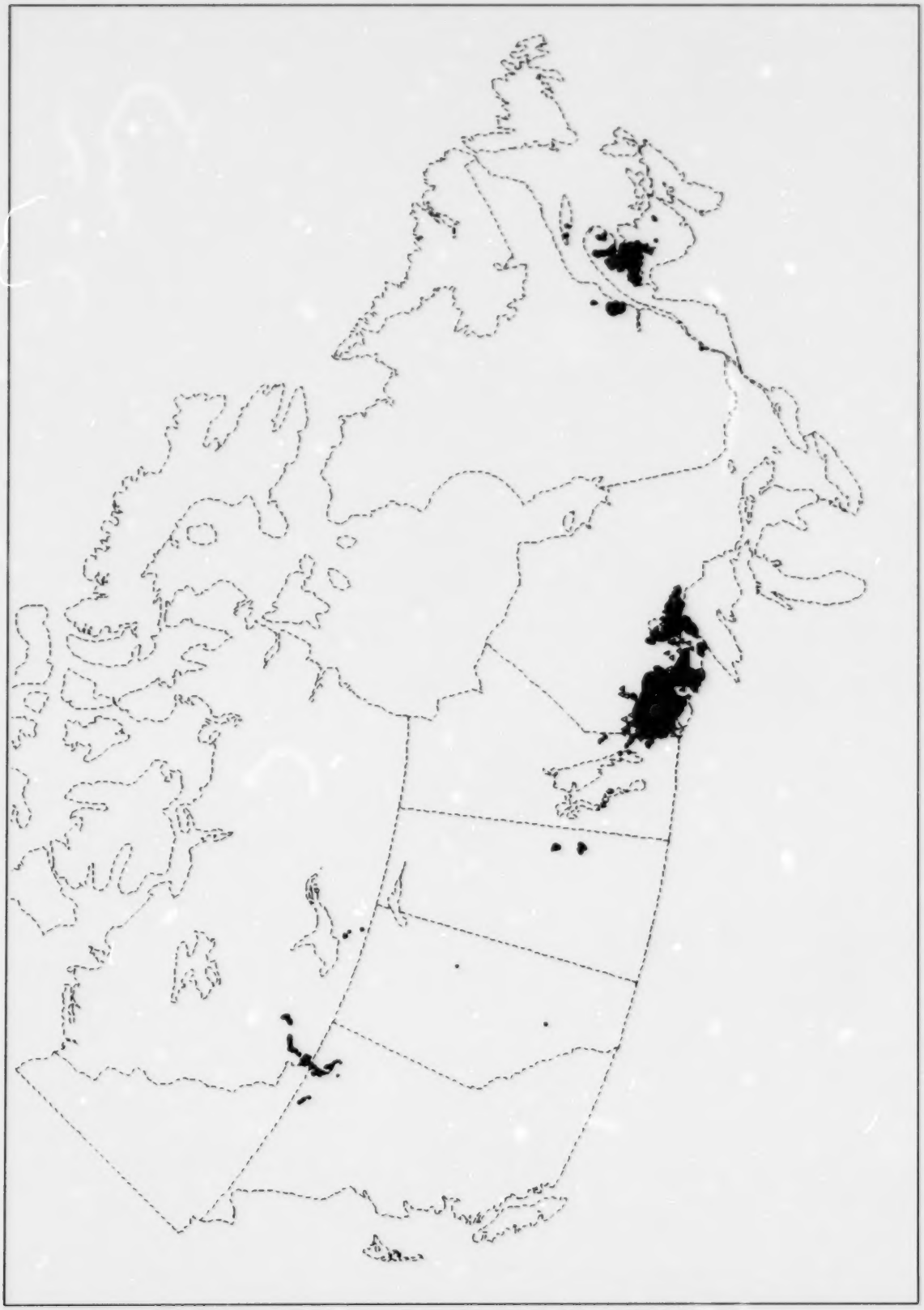

Figure 1: Areas of moderate to severe defoliation by the spruce budworm, 1988.

Major Forest Insects and Diseases

Spruce budworm

Choristoneura fumiferana (Clem.)

The spruce budworm remains Canada's most destructive forest pest. Balsam fir is the preferred host of the spruce budworm although it feeds heavily on red spruce, white spruce and, to a lesser extent, on black spruce. At very high population levels, this budworm will also attack hemlock and larch. In 1988 populations continued to decline from 1987 levels in Canada and the area within which moderate to severe defoliation occurred decreased to 6.3 million ha (Figure 1) from 8.4 million ha. Spruce budworm populations and the area of defoliation have shown a marked overall downward trend in eastern North America during the last few years; despite this some areas show an increase in incidence.

In Newfoundland, the budworm population decreased slightly. The insect caused moderate to severe defoliation over 500 000 ha in New Brunswick in 1988 but there was no defoliation detected during aerial surveys in Nova Scotia and Prince Edward Island. In Quebec the infestation continued to decline, with 32% overall decrease since 1987. In Ontario, the area over which moderate to severe defoliation occurred decreased by 27% from that recorded in 1987.

Spruce budworm infestations increased significantly in size and intensity in Alberta and Manitoba but slightly so in the Northwest Territories. Infestations remained at approximately the same level in Saskatchewan. In British Columbia, the infestations in alpine fir and white spruce decreased to 40% of the 1987 figures.

Aerial spray operations were conducted in Alberta, Manitoba, Ontario, Quebec, and New Brunswick covering a total of 0.7 million ha. Table 2 shows the areas of moderate to severe defoliation by province and the areas sprayed to control spruce budworm in 1988. Table 3 shows areas defoliated and sprayed since 1980.

Table 2. Area of moderate to severe defoliation by province and area sprayed to control spruce budworm in 1988

Province	Area of moderate to severe defoliation ('000 ha)	Area sprayed ('000 ha)
Newfoundland	2.0	0
Prince Edward Island	0	0
Nova Scotia	0	0
New Brunswick	500.0	546.2
Québec	434.0	192.1
Ontario	5224.7	14.0
Manitoba	15.0	1.1
Saskatchewan	31.6	0
Alberta	61.0	*
Northwest Territories	14.0	0
British Columbia	36.0**	*
Total	6318.3	753.4

* Less than 1000 ha.
** Light to moderate defoliation

Table 3. Area of moderate to severe defoliation and area sprayed to control spruce budworm since 1980 in Canada.

Year	Area of moderate to severe defoliation ('000 000 ha)	Area sprayed ('000 000 ha)
1980	36.2	1.9
1981	37.0	2.9
1982	18.2	3.0
1983	23.8	3.1
1984	16.8	2.0
1985	20.2	1.5
1986	12.3	0.8
1987	8.4	0.9
1988	6.3	0.7

Erratum: In the 1987 Report, ('000 ha) should have read ('000 000 ha).

Newfoundland

Defoliation - Population levels in the three small infestations at South Branch, Baie Verte, and Ten Mile Lake decreased in 1988. Larval numbers were high initially in the South Branch area and moderate to severe defoliation occurred near Overfalls Brook and Molychignic Brook in western Newfoundland (Figure 1). Larval numbers were low near Southwest Brook on the Baie Verte Peninsula and very few spruce budworm larvae were recorded in the Ten Mile Lake infestation where most of the defoliation was caused by blackheaded budworm.

General sampling during early summer showed an increase in spruce budworm populations along the west coast of the Northern Peninsula; however, populations decreased during later instars and in some areas budworm populations collapsed. Per cent mortality by parasite averaged about 10% for budworm larvae and about 30% for pupae in the infestation near Baie Verte. Larval and pupal mortality from disease was about 1%.

Damage - No appreciable damage was detected in the Region.

Control - No operational or experimental control program was conducted against the spruce budworm in 1988.

The main larval parasites were *Glypta fumiferanae* and *Apanteles fumiferanae*. The commonest fungal pathogen was *Paecilomyces farinosus* which caused about 1% infection. Less than 1% of the samples were infected by *Nosema fumiferanae*. The fungus *Entomophaga aucilae* did not occur in budworm populations in 1988, although about 4% of the budworm samples were infected by a fungus tentatively identified as *Aureobasidium pullulans*.

Pheromone traps were placed at 50 permanent sample locations throughout the Island. The number of moths trapped decreased from 477 in 1987 to 186 in 1988. This is the third consecutive year of decrease. Most moths were trapped along the west coast, with the highest numbers

recorded at Overfalls Brook (136) near an infestation. The number of moths trapped ranged from 1-10 at nine of 16 locations along the west coast, extending as far north as Daniel's Harbour, and no moths were trapped at the other seven sites. Only two moths were trapped near an infestation on the Baie Verte Peninsula while, about 40 km inland, three sites produced a total of four budworm moths. No moths were trapped in central or eastern Newfoundland.

Forecast - The egg survey to forecast the 1989 infestation was conducted in 122 locations throughout the island in conjunction with the hemlock looper egg survey in mid-October. Moderate and severe defoliation is forecast to occur in three areas totalling 1200 ha: one near South Branch, one at Codroy Pond, and the third near Southwest Brook on the Baie Verte Peninsula. Light defoliation is forecast in numerous small patches distributed from the Codroy Valley to Bonne Bay in western Newfoundland and from Baie Verte to Gander in central Newfoundland. One isolated light infestation is also expected near Hawkes Bay on the Northern Peninsula and near Whitbourne on the Avalon Peninsula. Light defoliation is forecast to occur on about 9000 ha in 1989.

Nova Scotia

Defoliation - For the second consecutive year, there was no defoliation of balsam fir or spruce detectable during the annual spruce budworm aerial survey in Nova Scotia in 1988. Only trace defoliation was detected during ground surveys on small groups of trees in previously damaged areas of the Province.

Damage - There were no specific budworm damage surveys conducted by the Forest Insect and Disease Survey in Nova Scotia in 1988.

Control - No control measures on an operational scale were carried out against the spruce budworm in Nova Scotia for the survey year.

Forecast - The overwintering larval (L_2) survey was conducted by the Nova Scotia Department of Lands and Forests, with sampling assistance from Bowater-Mersey Ltd. personnel. Information from 224 sample locations indicated that the dramatic decline of spruce budworm populations will continue. L_2 populations were negative at 61% of the locations sampled, low at 38%, and moderate at 1%. Moderate populations were found only in Antigonish (1 of 14 samples) and Annapolis (2 of 16 samples) counties. Defoliation, if any, in 1989 is expected to be confined to small, isolated patches of fir and spruce trees in these counties.

Prince Edward Island

Defoliation - For the second consecutive year, there was no defoliation of balsam fir or spruce detectable during the annual spruce budworm aerial survey in Prince Edward Island. Ground surveys detected moderate to light defoliation only in scattered white spruce stands and hedges in the Cardigan, Montague, and Georgetown areas in the southern part of Kings County.

Damage - No specific spruce budworm damage surveys were conducted by FIDS for 1988.

Control - Control measures on an operational scale against the spruce budworm were not carried out in Prince Edward Island in 1988.

Forecast - The survey of overwintering larvae (L_2) was conducted by Forestry Canada - Maritimes at 40 locations. Populations were reduced again from 1987 indicating that no significant defoliation is to be expected in 1989. Populations were high at 3% of the locations sampled, moderate at 13%, low at 65%, and nil at 20%.

New Brunswick

Defoliation - Defoliation of balsam fir and spruce stands was recorded on 543 000 ha in the Province in 1988 (Figure 1). Defoliation was severe on 304 000 ha, moderate on 196 000 ha, and light on 43 000 ha. The 500 000 ha of severe to moderate defoliation was only slightly larger than the 430 000 ha recorded in these categories for 1987. Most defoliation occurred in the northern half of the Province.

Damage - There were no specific spruce budworm damage surveys conducted by FIDS for the survey year.

Control - Foliage protection against the spruce budworm in New Brunswick was conducted over 546 200 ha in 1988: 448 000 ha by Forest Protection Ltd. and 98 200 ha by Forest Patrol Ltd., a subsidiary of J.D. Irving Ltd.

Forest Protection Ltd. treated approximately 238 000 ha of forest with two applications of fenitrothion (Sumithion®), and approximately 210 000 ha with the biological insecticide *B.t.* (Dipel 132® and Futura XLV®). The rates of application were primarily 2 x 210 g/ha for fenitrothion, and 1 x 30 BIU/ha for *B.t.* Most of the chemical treatments were applied in water-based formulations, while *B.t.* was applied undiluted.

Forest Patrol Ltd. used fenitrothion (Sumithion®) in two applications on 70% of the treated area (68 000 ha) and one application on 15% (14 800 ha). A single application of fenitrothion, followed by an application of *B.t.* (Dipel 176®), was used on 10% (10 200 ha) and 5% (4 600 ha) received a single application of *B.t.*

Fenitrothion was applied at the rate of 210 g/ha, in either ULV (ultralow volume; 0.73 L/ha) or UULV (ultra-ultralow volume; 0.42 L/ha) spray mixtures. The *B.t.* product (Dipel 176®) was applied at 1.78 L/ha to deliver 30 BIU/ha in a single application.

Forecast - The overwintering larval (L_2) survey was conducted by the New Brunswick Department of Natural Resources at 1204 locations. Approximately 350 locations sampled in previous years were not sampled in 1988 in the southern part of the Province where the infestation has collapsed over the past several years. L_2 populations of spruce budworm were low at 73% of the areas sampled, moderate at 19% and high at 8%. The forecast for 1989 is for 1.65 million hectares of variable and moderate to severe defoliation. The most severe damage is expected to occur in the northern part of New Brunswick. No significant damage is expected in the southern half of the Province or throughout much of the western and eastern areas.

Québec

Defoliation - In 1988, spruce budworm populations continued to decline in the administrative regions of Montreal, Trois-Rivières, and the North Shore. However, a new outbreak was observed in several areas of the Lower St. Lawrence - Gaspé Peninsula region, with very severe damage occurring in the central part of the Peninsula. In the other regions of Quebec, spruce budworm populations remained at an endemic level (Figure 1).

The spruce budworm infestation covered an area of 708 000 ha in 1988, down from 1 040 000 ha in 1987 (Table 4). Damage was light on 27 000 ha, moderate on 169 000 ha, and severe on 26 000 ha. The overall decline observed in 1988 corresponds to 32% compared to 1987; there was a 100% decline in the administrative region of Montreal, a 79% decline in Trois-Rivières, and a 76% decline in the North Shore. However, infested areas in the Lower St. Lawrence - Gaspé Peninsula region increased by 5% and defoliation was more severe.

Spruce budworm populations declined in all pockets that had persisted in 1987 in the regions of Montreal and Trois-Rivières. No defoliation was observed in 1988 in the Montreal region, whereas light defoliation was recorded in the Trois-Rivières area. Spruce budworm populations disappeared completely in the vicinity of Sainte-Émilie-de-l'Énergie and in areas located north of the Matawin River. The few pockets of defoliation present were located in the central part of the Mastigouche Wildlife Reserve (Lake au Sorcier) and southwest of Mauricie National Park (Lake Wapizagonke). In central Quebec, the infestation affected only approximately 8 300 ha in 1988, down from 42 000 ha in 1987.

The spruce budworm maintained its hold on the entire Lower St. Lawrence - Gaspé Peninsula region which it had infested in 1987. A new outbreak was observed in the vast area between the Rimouski and Petite Cascapédia Est rivers.

After several years of low populations, new spruce budworm outbreaks have been reported in a number of localized sectors between the Rimouski and Matapédia rivers. These outbreaks occurred primarily north of the infestation recorded in 1987, that is, in the northern part of the Rimouski Reserve and north of the Mistigougèche and Milnikek rivers. However, defoliation was generally light, with the exception of a major pocket of moderate to severe

Table 4. Areas (ha) affected by the spruce budworm infestation administrative regions of Québec in 1988, excluding mortality zones.

Administrative regions	Level of infestation			
	Light (ha)	Moderate (ha)	Severe (ha)	Total (ha)
Lower St. Lawrence - Gaspé	235 431 (240 344)*	138 348 (232 269)	220 773 (93 722)	594 552 (566 335)
Saguenay—Lac-Saint-Jean	- -	- -	- -	- -
Québec City	- (156)	- -	- -	- (156)
Trois-Rivières	(7500) (29 063)	781 (8594)	- -	8281 (37 657)
Eastern Townships	- -	- -	- -	- -
Montréal	- (2969)	- (1094)	- -	- (4063)
Outaouais	- -	- -	- -	- -
Abitibi - Témiscamingue	- -	- -	- -	- -
North Shore	31 094 (29 340)	29 689 (111 957)	44 531 (292 146)	105 314 (433 443)
Province	274 025 (301 872)	168 818 (353 914)	265 304 (385 868)	708 147 (1 041 654)

*Areas affected in 1987 are in brackets

defoliation between Mistigougèche and à-la-Croix lakes. Again this year, the spruce budworm caused severe damage in untreated areas near the New Brunswick border (area bounded by Lake Rimouski, Lake Mistigougèche, the Patapédia River, and the New Brunswick border). Damage was less extensive and less severe in 1988 south of the Matapédia Valley, along the Patapédia and Restigouche rivers. In the central part of the Gaspé Peninsula, the infestation covered virtually the same area as in 1987. However, defoliation was much more severe this year. On the other hand, the population decline that began in the eastern part of the Gaspé Peninsula in 1987 continued in 1988.

On the North Shore, the spruce budworm population declined substantially in 1988. Only 105 000 ha were affected, compared to 433 000 ha in 1987. However, the sectors in which the spruce budworm persisted in 1988 were seriously affected, suffering moderate to severe defoliation. The damage was localized around Labrieville-Sud, in the Boucher, Laliberté, Volant, and Betsiamites river basins and around Forrest, Jeffrey, Laval, MacDonald, Bilodeau, Trompeur, Pierson, and Reid lakes. Only one other pocket of moderate defoliation was detected on the North Shore; it was located northeast of the Manic 2 reservoir in the Toulnustouc River basin. In other parts of the North Shore the spruce budworm and damage caused by it were detected at trace levels only.

Spruce budworm populations on Anticosti Island also declined. The decline was significant in the area between lakes Geneviève and aux Cailloux. Only one pocket of severe infestation near Lake aux Cailloux remained in this area.

Damage - There were no specific spruce budworm damage surveys in 1988.

Control - The Quebec Department of Energy and Resources conducted the nineteenth aerial spray program to control the spruce budworm. A total of 192 073 ha of forest in the Lower St. Lawrence - Gaspé region only were treated, an increase of 9% over last year for the same area. In 1987, a total of 197 992 ha were treated: 21 563 ha on the North Shore and 176 429 ha in the lower St. Lawrence - Gaspé region.

Dipel® 132 (*Bacillus thuringiensis* var. *kurstaki*) was applied in the pure state over the entire area at 30 BIU/ha at a rate of 2.37 L/ha. The insecticide was applied between June 3 and June 25 using aircraft. The weather conditions (rain, wind, and fog) considerably affected the results of the 1988 spray program.

The aerial spraying of biological insecticide produced satisfactory results, albeit slightly inferior to those of past years. Average defoliation of trees and total mortality of the spruce budworm recorded in the treated areas were 45% and 81%, respectively, compared to 65% and 61% in the control plots. The treatment protected 35% of the annual foliage in stands where spruce budworm populations ranged from small to large, and 19% of the annual foliage in severely infested stands. In sectors where larval populations were high, the treatment was not effective in reducing populations or preventing extensive defoliation. An aerial survey revealed that 14% of the area treated was severely defoliated, and that 65% of the area was lightly defoliated. Adjustments will be made in 1989 in the sectors containing high populations; a second application of biological insecticide should be made on these areas.

Forecast - In recent years, the evaluation of hibernating larval populations (L_2), and monitoring male moth populations by the pheromone trap network, have been used to predict the levels of spruce budworm infestation the following year. However, for this year, only L_2 survey of hibernating larval populations will be used to make forecasts for 1989 because the data required for calibrating results obtained in the pheromone trap network are incomplete.

Sampling of hibernating populations was conducted at 1176 locations in eastern Quebec and in those areas of central Quebec affected by the spruce budworm in 1988. The surveys were intensified in target forest stands selected for their growth potential in order to predict the level of infestation in 1989 as accurately as possible. Outside these stands, extensive sampling was conducted with a view to predict the extent of infestations the following year.

The results indicate that spruce budworm populations should continue to decline in 1989 in all regions studied, with the exception of the Lower St. Lawrence - Gaspé region. The infestation will persist in all areas between the Rimouski and Bonaventure rivers. Larval populations will increase significantly in the central and south parts of the Gaspé Peninsula, where very severe damage is expected. Most of the areas infested in 1988 should expand somewhat in 1989, and several areas north of the Rimouski Reserve, north of Monts Chic-Chocs and in Baie-des-Chaleurs, will again be affected by the insect after several years of low populations. The populations will also remain in the pockets of infestation that persisted in 1988 in the eastern and western ends of the Gaspé. Finally, spruce budworm populations will continue to decline in the regions of Trois-Rivières and the North Shore, although some small areas will suffer extensive damage again in 1989. Residual pockets will remain south of Mauricie National Park, the area affected in 1988 north of Forestville, and at a number of sites between Hauterive and Port-Cartier.

Ontario

Defoliation - The area of moderate to severe defoliation by spruce budworm in Ontario declined for the third consecutive year. Altogether, 5 224 734 ha of moderate to severe defoliation were mapped by ground and aerial surveys, a reduction of 1 965 029 ha or 27% from the 7 189 763 ha recorded in 1987. All the defoliation occurred in the Northwestern and North Central regions, with the remainder of the Province free of defoliation for the first time in many years. Most of the population decline of the budworm occurred in the North Central Region, with substantial reductions in all five districts. Unfortunately, these declines were partially offset by increases in the Dryden, Kenora, and Red Lake districts.

The remaining infestation occurs in two large pockets and a number of smaller ones. The largest encompasses some 3 889 027 ha from the Manitoba border east to south central Thunder Bay District. The second occupies 820 249 ha between eastern Thunder Bay District and the southwest

corner of Geraldton District. An additional 165 pockets were mapped around the larger infestations, ranging in size from a few hectares to 52 516 ha.

Damage - Surveys of budworm-induced mortality revealed approximately 448 637 ha of new mortality in the Northwestern and North Central regions. The total area recorded during the current spruce budworm outbreak increased to 14 515 719 ha.

Control - The Ontario Ministry of Natural Resources carried out aerial spraying operations on 14 023 ha in 1988 in the Nipigon and Thunder Bay districts of the North Central Region. The program included commercial forest stands of balsam fir, spruce plantations, and one provincial park. A single application of Dipel 132® was delivered to the infested trees by helicopter at the rate of 30 BIU/2.4L/ha. Spraying operations began on May 30 and were completed June 17.

Forecast - The annual spruce budworm egg-mass survey was carried out in August with a total of 430 locations sampled province-wide. An analysis of the results shows an overall increase of 7% in egg-mass densities. On a regional basis, egg-mass densities declined by some 24% in the Northwestern Region; however, numbers remain sufficiently high that moderate to severe defoliation is likely to persist in most areas infested in 1988 although little or no expansion is expected. In the North Central Region where egg-mass densities increased by 85% overall, infestations will probably intensify and defoliation increase within areas affected last year. Few changes are expected in the area infested, except perhaps in the eastern section of the outbreak where some expansion may occur along the northern edge of the outbreak in the eastern Nipigon District, the western Terrace Bay District, and the southwest corner of Geraldton District. Although egg-mass densities increased in the Northeastern Region and in southern Ontario, the numbers remain at very low levels and no defoliation of any consequence is expected in these areas in 1989.

Manitoba

Defoliation - A significant increase in the size of areas defoliated by the spruce budworm was reported in 1988. Varying degrees of injury to white spruce-balsam fir forests were mapped over a total area of 30 821 ha compared to the 15 540 ha reported in 1987. Most of the spruce budworm infestations continued in the southeastern part of the province. Moderate to severe defoliation was especially notable in Whiteshell Provincial Park and near Lake Wanipigow in the Lake Winnipeg East forest section. Light defoliation was present throughout the remainder of the general infestation area.

Control - About 1000 ha of recreational spruce-fir forests in eastern Manitoba were treated with *B.t.*

Saskatchewan

Defoliation - Spruce budworm infestation remained fairly static in the outbreak areas previously reported in the east-central part of the Province. The overall total area of defoliation reported in 1988 remained unchanged from 1987 at 31 600 ha (Table 2).

In the Porcupine Hills infestation south of Hudson Bay, moderate to severe defoliation persisted in mature white spruce stands in the general area bordered by Eldridge Lake, Tall Pines, Mann Lake, Usherville, and McKinnon, Decorby, and White lakes. West of this main infestation, similar defoliation was reported in two other separate spruce areas, one bordered by the Piwei River and Eagle, Jim, and Arp lakes and the other by Big Valley, Weldon, and Kotoss lakes. The overall total area defoliated in all infestations totaled 16 600 ha.

In the Red Earth outbreak area, infestation levels remained much the same as reported for 1987 when a total area of 15 000 ha of white spruce was damaged. Moderate to severe defoliation was reported in the area northwest of the Carrot River and south of Highway 55 to the Pasquia Hills.

Control - Timber harvesting is continuing in most of the infestation areas to salvage damaged trees.

Alberta

Defoliation - In northwestern Alberta, approximately 650 ha of moderate to severe defoliation of mature white spruce was reported in the Grande Prairie Forest along the banks of the Peace River north of Eaglesham. In the Footner Lake Forest, a marked increase in the total area of defoliation was evident in white spruce stands in the Chinchaga River area west of High Level. Light to moderate defoliation was reported over a total area of 61 050 ha compared to 9480 ha in 1987. The infestation in the Chinchaga River area was surveyed aerially by the Alberta Forest Service, and ground monitoring was a cooperative undertaking by Forestry Canada and the Alberta Forest Service under the Canada-Alberta Forest Resource Development Agreement.

In the Lac La Biche Forest, approximately 200 ha of light to moderate defoliation was reported in white spruce near the confluence of the Athabasca and House rivers.

Light defoliation was reported in Big Knife Provincial Park and along the northeast boundary of Red Lodge Provincial Park in the central part of the province.

Control - Several small scale control operations were exercised using the biological insecticide *Bacillus thuringiensis*. Areas treated were Big Knife Provincial Park (100 ha) and a small private woodlot near Millet (50 ha) in Alberta.

Northwest Territories

Defoliation - The spruce budworm infestation that has been present along the Liard River for several years continued to cause varying degrees of injury to

approximately the same area as in 1987. A combined total of 14 350 ha of noticeable defoliation was mapped in 1988. Light to moderate injury was again evident in white spruce stands on Long Island and along the adjacent shoreline. In this area both white and black spruce were affected. Patches of light to moderate defoliation were also reported along the Slave River north of Fort Smith, near the mouth of the Salt River. Light defoliation was evident in a small infestation near Hook Lake.

British Columbia

Current foliage of white spruce and alpine fir was lightly defoliated by spruce budworm over 36 000 ha in 130 separate infestations north and west of Fort Nelson. This was a decline of 40% from 1987. Defoliation extended into the Northwest and Yukon territories. The decline was mostly in the Fort Nelson River Valley and at Kledo Creek; despite this the understorey was severely defoliated. Defoliation declined to a lesser extent in the Coal and Smith River areas and at Liard Hot Springs. Three 50-ha seed collection blocks near Fort Nelson were aerially treated with *Bacillus thuringiensis* by the British Columbia Forest Service.

Western spruce budworms

Choristoneura spp.

British Columbia

The western spruce budworm *Choristoneura occidentalis* Free. is the most widely distributed and damaging defoliator of coniferous forests in western North America. Despite its common name, within British Columbia this insect feeds primarily on Douglas-fir. Other conifer-feeding budworms currently active in British Columbia include the two-year-cycle budworm *C. biennis* Free., and the eastern spruce budworm *C. fumiferana* (Clem.) which extends into northeastern British Columbia.

Since 1900, at least six western spruce budworm infestations of varying duration have occurred at irregular intervals in southern British Columbia. The effects of defoliation include loss of radial and height growth, top-kill and resulting defects, and some tree mortality. The Fraser Canyon infestation that started in the late 1960s peaked in 1977 with 214 300 ha defoliated. However, populations then began increasing in drier interior stands east of Cache Creek, culminating in more than 834 000 ha infested. Mortality of understorey regeneration in these stands, although largely unquantified, is of greater concern than in the wetter zones previously infested.

After three successive years of expansion, the total area of defoliation of mixed-aged Douglas-fir by western spruce budworm declined in 1988 to 359 670 ha in the southern interior of British Columbia (Figure 2a, b). This is less than half the area affected in 1987. More than 1220 infested areas were aerially sketchmapped and, of these, 96% were in the Kamloops Region, 2% in the Cariboo Region, and 1% in each of Vancouver and Nelson regions. The intensity of defoliation also declined; defoliation was light on 83% of the

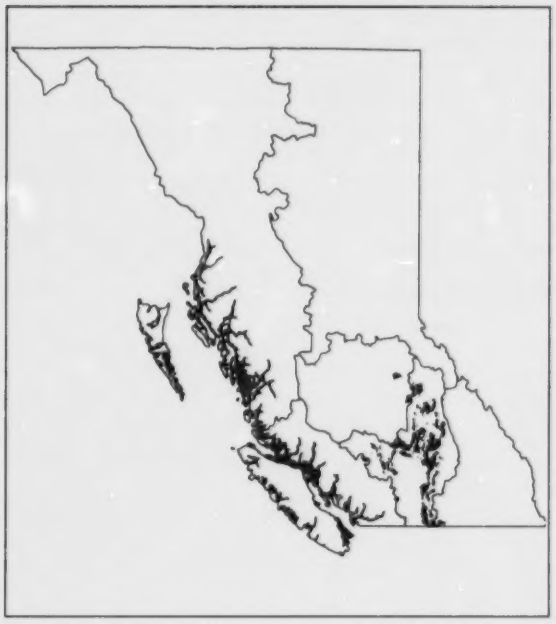

Figure 2a: Area of defoliation by western spruce budworm in British Columbia, 1988.

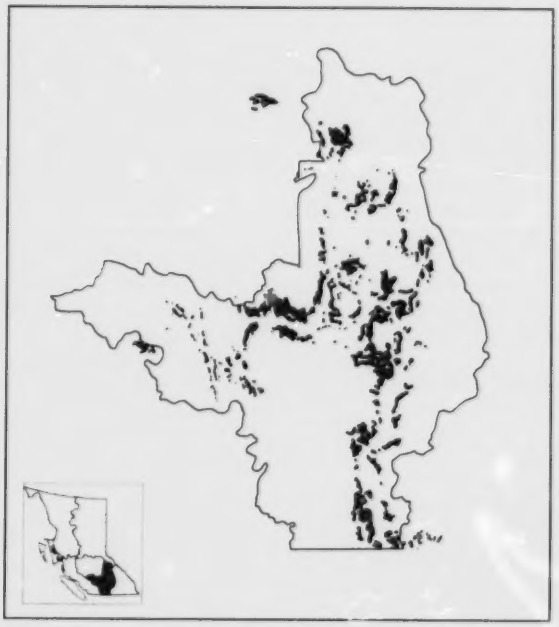

Figure 2b: Area in Figure 2a enlarged to show detail.

area, moderate on 16%, and severe on 1%. Severe defoliation covered 3400 ha, mostly in the Shuswap Lake area, and near Vernon, Kelowna, and Penticton. Moderate defoliation was mapped over 60 000 ha in 184 infestations, mostly in the Kamloops Region and to a lesser extent in the Vancouver Region, with light defoliation over the remainder.

Of the total area infested since 1983, 48% has been defoliated for one year, 36% for two consecutive years, and 15% for three or four years. Only 1% has been defoliated for five or six consecutive years.

The greatest areas of decline occurred in the Lillooet and Kamloops regions including the Clearwater District and the eastern part of the Cariboo Region. Infestations in the Okanagan Valley, as well as those in the southwestern part of the Nelson Region and near Pemberton in the Vancouver Region, expanded slightly.

Parasitism of early- and late-instar larvae occurred at all 26 sites sampled and averaged 16% (range 1 to 54%); this level of parasitism is similar to that found in 1987, but it is still too low to effectively reduce populations. The cause of the decline has been attributed to larval starvation in chronically infested areas and, possibly, to the depletion of nutrient reserves of early-instar larvae following emergence during a prolonged warm dry fall in 1987.

Egg sample assessments at 52 locations in four regions indicate light to moderate defoliation in 1989 in most areas. However, defoliation is still forecast to be severe at 10 of the sites (of which six are in the Nelson Region), moderate at 16 sites, light at 21 sites, and absent at five sites. Egg masses were, on average, 70% less numerous at 28 of the 36 locations sampled in both 1988 and 1987, and more numerous at only eight locations. Increases were noted in the following areas: in the south Okanagan at Equesis Creek, Glenrosa, and Mt. Kobau; in the Nelson Region at Anarchist Mountain, McKinney Creek, and Conkle Lake Road; in the Cariboo Region at Viewland Mountain; and in the Vancouver Region at Devine.

Tree mortality and growth loss is variable. Continued monitoring of long-term study plots in open-growing Douglas-fir near Cache Creek indicates that tree mortality averaged 30% to 40% in 1987, one year after collapse of the infestation in these stands. Decline in diameter increment in mature trees occurred 1 or 2 years after the first year of defoliation in 1979, and increment has been almost nil since 1982. Monitoring continued in 64 research plots established in young, open-growing Douglas-fir. These plots were established in 1986 in areas which had sustained 0 to 7 years of defoliation. As of 1988, tree mortality averaged 4.9% but varied widely (from 0 to 75%). A trend of increasing mortality with increasing number of years of defoliation is apparent. Greater damage exists where regeneration is overtopped by older trees.

Aerial spray trials of *Bacillus thuringiensis* (*B.t.*) were conducted by the British Columbia Forest Service over a total of 1800 ha including five new areas in the Kamloops Region, one in the Nelson Region, and the 11 blocks sprayed in the Kamloops Region in 1987. Preliminary results are mixed due to highly varied larval development and bud flush, and natural reduction of up to 80% of populations in 8 of 11 plots. At Paul Lake Park, sprayed each year since 1986, population reduction was 80% and no current defoliation was apparent; however, egg masses, likely from neighboring infestations, point to moderate defoliation in the area in 1989.

As part of a study to improve and calibrate detection methods for western spruce budworm, mid- to late-instar budworm larvae and adult males were monitored in four regions at 12 sites that still had low populations but with a history of budworm outbreaks. Up to 32 larvae per tree were collected per 1 m^2 beating (3 branches on 25 trees per plot) and up to 680 male adults were caught in 57 Multipher® traps.

Defoliation of alpine fir and spruce forests by 2-year-cycle budworm *Choristoneura biennis* Free. was light or moderate over 102 185 ha in 490 infestations in three forest regions (Figure 2b). This was more than double the area affected in 1987, which was largely a non-feeding year. The mature "on-year"-cycle budworm larvae defoliated 42 250 ha in the Kamloops Region, 40 215 ha in the Cariboo Region, and 17 500 ha in the Prince George Region. Immature "off-year"-cycle larvae infested alpine fir buds in 10 higher-elevation drainages in the Nelson Region and two drainages in the Kamloops Region. The area of mostly light defoliation of new shoots of fir-spruce in the Kamloops Region more than doubled in 159 areas in the North Thompson and Adams river drainages. New infestations occurred north of Tranquille River. Four pockets of light defoliation totalling 1000 ha were mapped east of Mabel Lake and in the Shuswap River drainage.

In the Cariboo Region, defoliation of mature and immature Engelmann spruce and alpine fir in the northeastern part increased nearly fourfold to 40 215 ha in 240 separate infestations. Defoliation was mostly light on 39 250 ha and moderate on the remainder. Most of the feeding occurred east of Williams Lake and near Quesnel Lake.

In the southeastern and eastern parts of the Prince George Region, alpine fir and spruce were defoliated over 17 500 ha in the Bowron and Morkill river drainage areas. Defoliation in 88 separate infestations by mature larvae was moderate on over half the areas and light over the remainder.

In the Nelson Forest Region, 2-year "off-year"-cycle immature larvae infested 5 to 100% (average 31%) of the buds in seven higher-elevation stands in the East Kootenay and about one-quarter of the buds in three previously infested fir-spruce stands in the West Kootenay. Defoliation of new tips by maturing second-year larvae is forecast to occur in 1989 in the Cranbrook, Invermere, and the Arrow Lakes areas in the West Kootenay. Consecutive years of severe defoliation of alpine fir and spruce of intermediate age in the upper St. Mary River drainage west of Kimberley has resulted in the loss of up to 90% of the foliage on half the trees. In the eastern part of the Kamloops Region, populations increased in 15 pockets totalling 2200 ha in the Upper Kettle River Valley and lightly defoliated the current year's shoots.

Egg samples at 15 infested sites in the Kamloops, Cariboo, and Prince George regions forecast high numbers of immature budworm larvae in new buds in 1989 in the

Cariboo and Prince George regions, but fewer larvae are forecast in the Kamloops Region.

Larvae and adult male populations continued to be monitored in three regions to improve and calibrate methods to detect budworm populations in fir-spruce forests. Up to 34 adult males were collected in 13 non-sticky Universal® traps at three locations. Further study, however, is necessary before numbers can be correlated with population damage and potential.

Western blackheaded budworm
Acleris gloverana (Wlshm.), and
Hemlock sawfly
Neodiprion tsugae Middleton

British Columbia

Western blackheaded budworm has caused extensive defoliation, top-kill, and some tree mortality in western hemlock forests in British Columbia periodically since the 1940s. Infestations occurred in coastal forests of all ages on northern Vancouver Island and the Queen Charlotte Islands in the mid-1940s, the 1950s, and early 1970s. Flareups have occurred in interior, usually overmature, wet belt forests in the mid-1950s, the 1960s, and the 1980s, but these have subsided without appreciable damage. Hemlock sawfly is a common associate of budworm and may follow budworm infestations.

Blackheaded budworm and hemlock sawfly populations declined after three consecutive years of feeding. Western hemlock over about 7350 ha on the Queen Charlotte Islands were defoliated mostly by sawfly populations, down from 14 100 ha in 1987. Defoliation was severe for 3% of the area, moderate for 33%, and light for the remainder. Populations in the Kamloops Region declined slightly to 875 ha following an increase in 1987. Near Holberg on northern Vancouver Island, mature western hemlock over 4830 ha were defoliated, up from 5 ha in 1987. In the eastern part of the Prince Rupert Region, where budworm populations in alpine fir stands have been common but fluctuated since 1982, new shoots over 58 670 ha were lightly to severely defoliated. Increased populations near Germansen Landing lightly infested white spruce.

On the Queen Charlotte Islands, significantly reduced budworm populations lightly defoliated 10 ha near Tow Hill on Graham Island. Defoliation, mainly by the sawfly, is expected to decline further in 1989. Collections of hemlock sawfly cocoons were made at 15 sites to evaluate sawfly survival and levels of parasitism. Sawfly survival was generally low but variable; adults emerged from an average of only 13% of the cocoons (range 0 to 40%), with the highest survival rate at Harrison Island in Masset Inlet. Parasitism of cocoons by Ichneumonidae accounted for 34% of the mortality and the remainder was possibly caused by an entomopathogen. The highest parasitism (70%) occurred at Skidegate Narrows on Moresby Island.

Increased blackheaded budworm populations defoliated western hemlock over an estimated 4830 ha on northern Vancouver Island. The infestation affected all age classes of western hemlock on the southern shore of Holberg Inlet. Small scattered infestations were also noted in Cape Scott Park. Poor weather conditions prevented a more extensive survey which may have detected a greater area of defoliation. Defoliation is expected to increase in severity and area in 1989, based on the number of eggs per 10 m^2 of hemlock foliage at 10 sample sites near Holberg. The average egg count was 59 and ranged from 4 to 166. Based on relationships determined during past infestations, defoliation is forecast to be severe at three locations, moderate at five, and trace or light at two locations. Consecutive years of severe defoliation could result in some tree mortality or top-kill. The last recorded infestation on Vancouver Island, from 1970 to 1973, defoliated western hemlock and amabilis fir over 164 000 ha from Jordan River to Holberg.

Mature western hemlock in mixed hemlock-cedar stands in five pockets in the Kamloops Region were lightly to moderately defoliated over 875 ha, similar to 1987. Defoliation for the second consecutive year occurred in Wells Gray Provincial Park. No defoliation was seen in the Upper Adams River drainage where defoliation occurred in 1987.

In the Prince Rupert Region, light defoliation of new shoots of white spruce and alpine fir in the Morice River, McKendrick Pass, and Hudson Bay Mountain areas was similar to that in 1987. Defoliation occurred for the first time north and south of Houston. Egg counts at four locations indicate continuing light to moderate defoliation of new foliage in 1989 in these areas. Populations in white spruce north of Germansen Landing in the Prince George Region infested 10% of the shoots, up from endemic populations and trace defoliation in 1987.

Jack pine budworm
Choristoneura pinus pinus Free.

This close relative of the spruce budworm has long been regarded a serious pest of jack pine stands and plantations in northwestern Ontario, Manitoba, and Saskatchewan, and the Great Lakes States of the U.S.A. Only in recent years (1967-72) have destructive populations also occurred in central and eastern Ontario and Quebec. Tree mortality of up to 30-40% of the jack pine component in a stand may occur following two to three years of moderate to severe defoliation. Top-killing is also common and may result in half or more of the stand being damaged.

Ontario

Defoliation - Based on egg-mass counts and historical outbreak patterns, it was expected that jack pine budworm populations would collapse in 1988 with only a few scattered pockets of moderate defoliation expected in the Northwestern Region. Instead, populations rebounded with the total area of moderate to severe defoliation increasing from 504 749 ha in 1987 to 737 482 ha in 1988 (Figure 3). Populations collapsed as expected in the Dryden, Kenora,

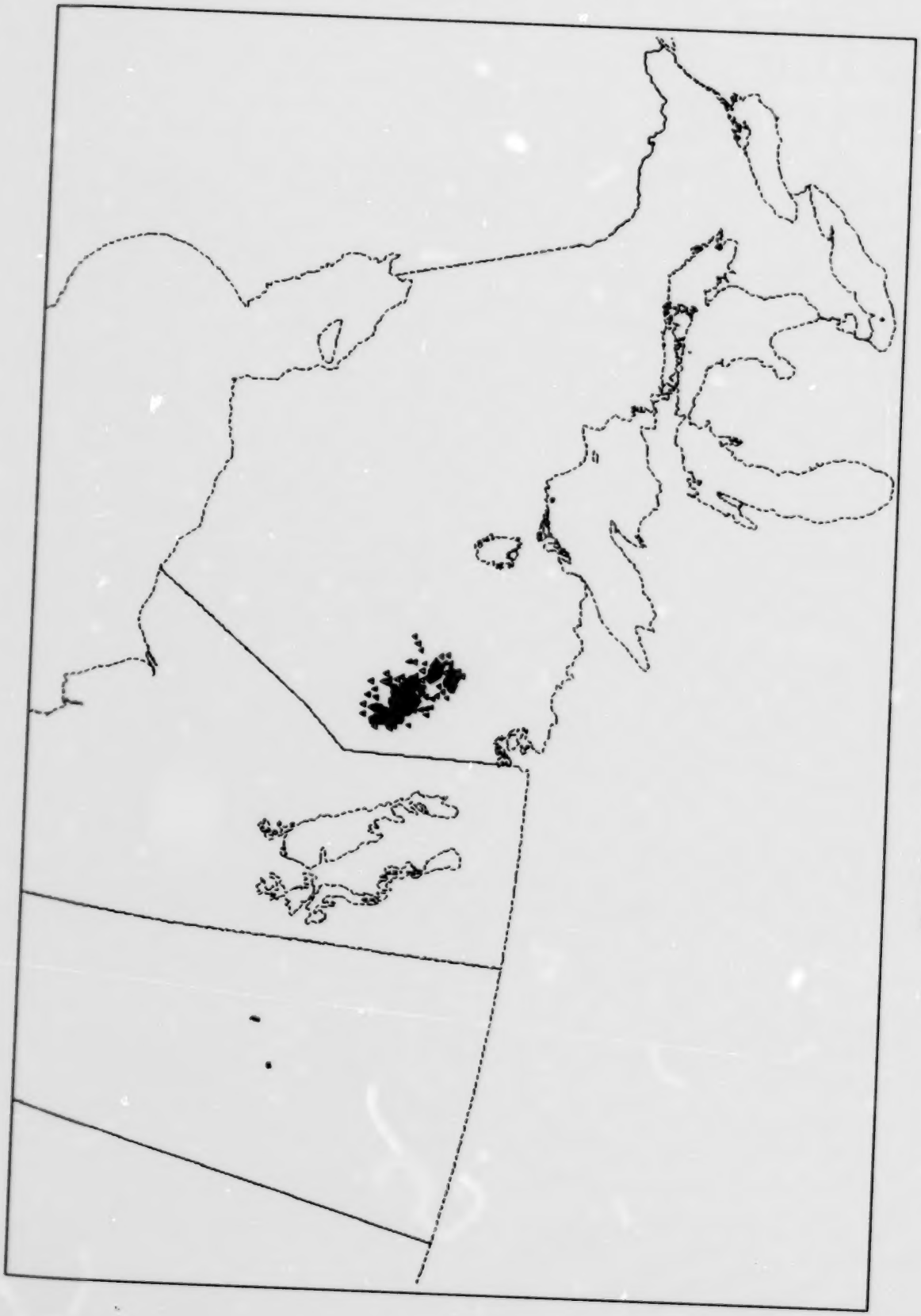

Figure 3: Areas of moderate to severe defoliation caused by jack pine budworm in 1988.

Fort Frances, and Ignace districts but major increases were recorded in the Red Lake and Sioux Lookout districts. The largest single infestation (504 749 ha) occurred in the central Red Lake District between Needler and McInnes lakes. Immediately south of this infestation, two pockets totalling 30 354 ha occurred in the Trout Lake area and two other pockets totalling 190 423 ha straddled the Red Lake-Sioux Lookout district boundary. The remainder of the defoliation consisted of numerous scattered pockets of varying size around and between the infestation described. In addition to the above, a small new area of mainly moderate defoliation was mapped over about 600 ha of jack pine stands in the English River area of Thunder Bay District in the North Central Region.

Damage - In the Red Lake District of the Northwestern Region, the area within which top-killing and tree mortality was recorded increased from 2 000 to 18 000 ha in 1988. All of this damage was recorded in the area northwest of Trout Lake where quantitative sampling at three locations revealed an average of 7% mortality and 11% bare tops. In the Northeastern Region, top-killing and tree mortality increased in some areas that have been free of defoliation for two years. In Sudbury District the average mortality at five locations increased from 4.6 to 14.6% and the number of trees with bare tops increased from 4.6 to 9.6% at the same locations. In Espanola District, records from four locations showed an increase in average mortality from 14.3 to 16.8% and an increase in bare tops from 12.8 to 20%. It is possible that drought conditions which prevailed throughout most of the Northeastern Region in 1988 were a major factor in the further deterioration of trees weakened by jack pine budworm.

Forecast - Results of a jack pine budworm egg-mass sampling program indicate that, for the most part, defoliation in 1989 will be confined to previously infested areas in Red Lake and Sioux Lookout districts with little or no spread from these areas. Defoliation could intensify within areas infested in 1988 but there is also a strong possibility that a buildup of parasites and predators, along with other natural control factors, may substantially reduce both defoliation and area affected in 1989. There is also evidence from egg-mass counts that populations may be building in the English River - Rush Creek area on the Thunder Bay - Ignace district boundary and infestations may intensify in 1989.

Prairie Provinces

In Manitoba, the jack pine budworm outbreak first reported in 1982 completely collapsed in 1988. Egg-mass samples were collected at 10 permanent plot locations to predict defoliation for 1989. Light defoliation will probably occur at two locations; no defoliation is predicted in the other eight. No egg-mass samples were taken in Alberta or Saskatchewan.

In Saskatchewan, defoliation was evident in only a few previously reported infestation areas. Patchy, moderate damage was reported in jack pine regeneration north of Smeaton and along Highway 106 between the Torch River and White Gull Creek. Similar damage was evident in a jack pine plantation and on fringe regeneration east of Prince Albert near Crutwell.

In Alberta, light defoliation persisted in jack pine stands in the Tawatinaw-Clyde area. No change in the total 70-ha infestation area, reported in 1987, was evident in 1988.

Mountain pine beetle

Dendroctonus ponderosae Hopk.

Lodgepole pine is the principal host of the mountain pine beetle, but several other western pine species are susceptible. The beetles attack trees in mid- to late summer and infect them with several microorganisms, including blue stain fungi. Eggs laid by female beetles yield larvae that feed on the inner bark. Infested trees generally die from the combined action of blue stain fungi and the beetle larvae. The foliage of killed trees usually turns red-brown in the year following attack and tree mortality can then be detected by aerial surveys.

Because most beetle-killed trees are of suitable size for saw logs, the monetary loss in commercial forests can be significant if trees are not salvaged quickly. Other consequences are a hastening of forest succession, a change in age and diameter distribution of the pine component of forests, a reduction in aesthetic values, and an increase in fire hazard. Each of these effects can force disruptive and costly changes in forest management plans. Many companies have shifted operations to concentrate on salvage of recently killed trees, particularly in British Columbia where large volumes of dead trees are involved.

Aerial and ground surveys were conducted in southwestern Alberta within the southern Bow-Crow Forest. No beetle-killed lodgepole or limber pine were observed.

British Columbia

Mountain pine beetle continues to be the most destructive forest insect in British Columbia. Outbreaks have been recorded at varying geographic locations within British Columbia and Alberta at irregular intervals since at least 1910. The current series of outbreaks started during the late 1960s and early 1970s. The area of newly red trees (attacked the previous year and often called faders) increased each year until 1984, with very rapid increases in the early 1980s. Cumulatively, over 207 million mature pine have been killed and harvesting plans throughout the Province have been severely affected.

The area and volume of lodgepole pine and some white pine killed by mountain pine beetle in 1988 declined overall by about 5% to the lowest level since 1977. However, more than 8550 infestations were still active on more than 62 925 ha from the international border south of Cranbrook to north of Terrace (Figure 4). This is more than six times the area burned by forest fires in British Columbia in 1988 and represents about 15% of the annual lodgepole pine harvested.

Declines due primarily to host depletion, including harvesting, occurred in four regions. These include the western part of Kamloops Region (down 10% to 17 650 ha), the Homathko and Lillooet river valleys in the Vancouver

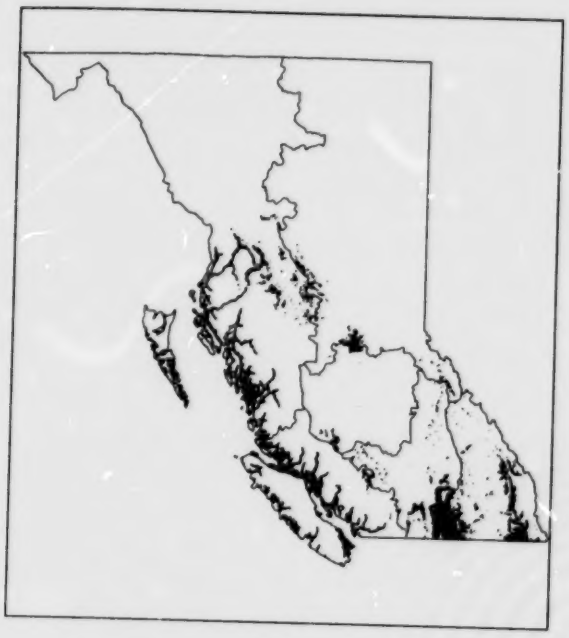

Figure 4: Mountain pine beetle mortality in British Columbia, 1988.

Region (down 40% to 845 ha), the Prince George, Vanderhoof, and Valemount areas in the Prince George Region (down 8% to 3975 ha) and the Morice River drainage in the Prince Rupert Region (down 30% to 12 975 ha). The area of pine killed by the beetle increased in two regions. In the Cariboo Region, where most populations were killed by below-normal temperatures in late 1984 and early 1985, new infestations near Chilko Lake more than doubled to 1300 ha. In the Nelson Region, infestations increased 12% to over 26 180 ha, mainly south of Cranbrook, and near Invermere and Grand Forks.

Overwintering brood mortality assessed in 42 major infestations in six forest regions in early 1988 was less than 10%. At 75% of the locations the ratios of progeny to parents was greater than 4.0 (range 0 to 37), indicating increasing populations for flight and attack in July. New attacks averaged 13% of the trees in 40 stands in six forest regions. Current attacks were higher in three regions, but down in the remainder. The highest was in the Nelson Region at 28% and ranged from 3% to 13% in the remainder.

In the Cariboo Region, pine mortality more than doubled to about 1300 ha near Chilko Lake but remained low elsewhere. Pine mortality is expected to remain generally at low levels throughout most of the region in 1989. In one stand near Chilko Lake, 13% of the stems were attacked by mountain pine beetle. Slash accumulations contributed to high engraver beetle (*Ips* spp.) populations, but standing green tree mortality was down significantly from 1987.

The area of mature pine killed by the beetle in 1988 in the Kamloops Region contained about 3.6 million trees (1 785 000 m^3). The decline, largely due to host depletion, occurred mainly around Lillooet where most mature susceptible lodgepole pine has been killed since 1972 when the outbreak first developed. However, active infestations continue east of Kelowna and Vernon, and west of the Okanagan Valley. White pine mortality was more numerous this year in the northern part of the region from Vavenby to Albreda.

Mountain pine beetle infestations in the Nelson Region contained 1.25 million trees (455 000 m^3). An additional 42 125 trees were killed over 605 ha in Kootenay, Glacier, and Revelstoke National Parks. Although infestations along the British Columbia-Alberta border continued to decline, those near Grand Forks, Cranbrook, Invermere, and in the southern part of Kootenay National Park increased for the second consecutive year to 4767 infestations. Newly attacked trees increased significantly to an average of 28% in 17 stands, indicating continued but varied amounts of tree mortality in 1989, with the highest at Bloom Creek (62%) south of Cranbrook and near Steamboat Mountain (43%) west of Invermere.

Following two consecutive years of increase, the area of lodgepole pine killed by the beetle in the Prince Rupert Region declined to 12 950 ha containing 1.0 million trees (632 000 m^3). This major decrease occurred mainly in the Morice and Nilkitkwa river valleys in the eastern part of the region. Tree mortality is forecast to decline with current attacks down to 12% overall (range 4 to 36%). In the northern part of the region, lodgepole pine beetle *D. murrayanae* Hopk. killed about 9000 mature lodgepole pine over 5800 ha.

Infestations declined about 10% in the Prince George Region to 3975 ha (100 000 trees, 72 000 m^3), mostly northwest of Fort St. James. Current attacks averaged 11%, indicating continuing populations in 1989. Pine beetle control operations in Mt. Robson Provincial Park continued for the fourth successive year, with 60 beetle-attacked trees to be treated, including 47 baited with pheromones.

The total area containing recently killed pine in the Vancouver Region declined by nearly half to 845 ha (21 000 trees, 15 000 m^3), and the number of infestations declined by a third. The decline, due to host depletion, was mostly in the Homathko River Valley and to a lesser extent, east of Pemberton.

Over five consecutive years of a special protection program, the B.C. Forest Service has allocated a total of $37 million ($8.1 million in 1988) towards road construction to extract threatened timber, for cut-and-burn or MSMA treatments to reduce the spread of bark beetles, for aerial photography and ground surveys, and for pheromones to monitor and aggregate beetle dispersal.

Salvage of beetle-killed and adjacent susceptible pine continued at high levels in most beetle-infested Timber Supply Areas. Salvage harvesting in advance of increased stumpage rates, and reduced availability of economically accessible beetle-killed pine may result in reduced harvest in the near future. Redirection of operators into the Okanagan Valley drainages due to expanding infestations resulted in increased transportation costs exceeding $1.4 million.

The Canada/U.S. Mountain Pine Beetle Program sponsored a symposium at Kalispell, Montana from July 12-14 on the management of lodgepole pine to minimize losses. Field tours and discussions included reviews of the status of the beetle on both sides of the border, silvicultural strategies, developments in semiochemical (pheromone)

use, risk assessment techniques, and effects on resource planning.

Alberta and Saskatchewan

Infestations of the mountain pine beetle remained at endemic levels in southwestern Alberta and Saskatchewan, and in the Rocky Mountain National Parks, except in the Kootenay and Yoho Parks in British Columbia. Estimated numbers of recently killed lodgepole pine are shown in Table 5 for the five Rocky Mountain National Parks.

In Jasper National Park there was no evidence of the mountain pine beetle in 1988. The previously reported beetle activity west of the Park in Mt. Robson Provincial Park has been monitored by the B.C. Forest Service, and all suspect and beetle-attacked trees were either removed or destroyed.

In Banff National Park, where a small infestation of the mountain pine beetle was reported in 1987 along the Spray River, all of the infested trees were cut and burned by Parks Canada personnel. No evidence of beetle-attacked trees was observed in the same location during aerial surveys in 1988. However, a few attacked (1988) trees were observed by the Alberta Forest Service among semiochemical-baited trees adjacent to Spray Lake and at Upper Kananaskis Lake. All successful attacks were hand removed without tree removal, and no tree mortality was observed. A total of 30 semiochemical baits were placed at 10 sites with three baits per site.

At Waterton Lakes National Park, new and recently killed (newly faded) lodgepole pine still occurred either singly or as small groups of two or three. No extensive areas of current beetle injury were evident within the Park.

In Yoho National Park, small scattered groups of beetle-killed pine were observed along both sides of the Emerald River, south of Emerald Lake, at several locations on the southeast slopes of Mt. Burgess, and in the Mt. Dennis area near Boulder Creek. Small pockets of previously killed pine were evident along Hamilton Ridge and along Tocher Ridge south of the Amiskwi River.

In Kootenay National Park, new infestations (1987 attacks) of the mountain pine beetle appeared to be similar to those reported in 1987 (Table 5). An estimated 1000 trees were newly killed between Radium and Settler's Road. In the area along the east side of the Kootenay River and extending from the south end of the Park to Mt. Selkirk, an additional estimated 2800 newly faded trees were mapped in about 70 patches of infested trees. About 20 of these patches, each with up to 200 dead trees, occurred along the lower slopes of Mounts Daer and Selkirk, while the major infestation continued between Daer and Pitts creeks. Several small patches of dead lodgepole pine were observed along the south slope of Mt. Wardle and along Dolly Varden Creek. These were attributed to porcupine damage.

Table 5. Estimated number of lodgepole pine trees killed by the mountain pine beetle in the Rocky Mountain national parks, surveyed in 1988

National Park	Estimated no. trees killed	
	1987	1988
Jasper	0	0
Banff	25	25
Waterton Lakes	220	60
Yoho	105	108
Kootenay	3870	3800

Spruce beetle

Dendroctonus rufipennis (Kby.)

The spruce beetle belongs to a genus of bark beetles that periodically cause significant mortality to the conifer forests of Canada. It infests all species of spruce in Canada, with white spruce and Sitka spruce the primary hosts. The annual mortality attributable to the spruce beetle is difficult to assess because much of the mortality, except for outbreaks, originates from scattered single or small groups of trees. Populations are normally endemic in forest debris and overmature timber. However, stand disturbances such as blowdown, cull, or right-of-way logging operations create breeding material which facilitates population buildup. Under outbreak conditions, attacks can occur on pole-sized, immature timber, and on atypical hosts such as lodgepole pine when these are mixed with the primary hosts.

British Columbia

The area and volume of mature white and Engelmann spruce killed by the spruce beetle in British Columbia declined for the sixth consecutive year. Host depletion, salvage, and sanitation contributed to the decline. Most of the 1675 ha of infested spruce mapped in aerial surveys was in about 20 separate infestations in previously infested stands, mainly in the Kamloops Region and to a lesser extent in the Nelson Region.

Recent mortality of mature spruce by spruce beetle in the Kamloops Region was confined largely to the Lillooet District in 10 infested areas totalling 1020 ha. Spot infestations of 10 to 15 trees occurred in the Fraser Canyon and older infestations in the Tulameen River drainage declined to 430 ha, primarily as a result of harvesting.

In the Nelson Region, populations largely in windthrow increased in the East Kootenay in seven areas totalling 225 ha from Creston to east of Golden. An average of six attacks in 500 cm^2 of bark samples (range 3 to 8) were common in fringe blowdown west of Kimberley, near Golden, and at the southern boundary of Glacier National Park. These small broods have the potential to survive and attack standing and windthrown spruce in 1989.

Along the Haines Road in the Prince Rupert Region, felled trap spruces and windthrow were attacked by the beetle for a second consecutive year. Road construction in 1983 predisposed the trees to attack and contributed to population buildup. Through cooperative programs infested trees were removed or felled and peeled to prevent an outbreak, but successive years of windthrow are sustaining populations in the area.

Timely salvage, sanitation, and host depletion should maintain present populations mostly in scattered windthrow, corridors, log decks, and butts of mature and overmature standing trees.

Maritime Provinces

Spruce beetle remained active throughout the Maritimes in 1988 and white spruce mortality occurred in all three provinces.

In New Brunswick, spruce beetle damage was reported in 1980 after a 50-year period of inactivity. Since then, the insect has been found in a number of widely separated areas, mostly in the southeastern and northwestern parts of the Province.

In 1988, spruce beetle populations declined sharply from levels of previous years and no newly infested trees were found at any of the known infestation areas, including those with the longest history along the Shepody Road in Fundy National Park and on Grand Manan Island. A single infested white spruce tree was found in the Tracy Brook area in Restigouche County.

In Nova Scotia, Cape Breton Island constituted the major outbreak area during the early part of the 1980s and, by the end of 1983, no large areas remained without severe white spruce mortality. Beetle activity decreased between 1984 and 1986 on Cape Breton Island, but there was an increase in the number of spruce beetle-attacked white spruce on the mainland. In 1987, the level of insect activity remained similar to that observed in 1986 with most of the tree mortality occurring on Cape Breton Island and on the northern mainland.

In 1988, the status of spruce beetle remained similar to that observed in 1987, with white spruce mortality occurring in scattered pockets in many areas of the Province. The majority of infestations was observed in northern Antigonish and Pictou counties and on Cape Breton Island.

Damage (infested living and dead trees) averaged 14% in stands examined and ranged from 0% to 20% in individual stands. The infested stand reported in 1987 at Big Mushamush Lake, Lunenburg County, was salvage-cut in 1988 but some infested trees still remain in the area.

In Prince Edward Island, spruce beetle killed an estimated one-third of the merchantable white spruce by 1983 when infestations peaked. Populations have decreased steadily since that time and in 1986 only a very few newly infested white spruce trees were observed in the Province. There was an increase in infestations in 1987. In 1988, infestations increased further and newly attacked or recently dead trees were observed in several areas in Kings and Queens counties, including Cavendish and Rustico Island in Prince Edward Island National Park.

Eastern larch beetle

Dendroctonus simplex Lec.

This insect normally attacks only weakened, damaged, or recently felled host material. However, when populations are very high, the insect can also attack living, apparently healthy, mature or overmature trees. Even younger, small diameter trees can become infested.

Maritimes Provinces

A population buildup was first noticed in Nova Scotia in 1976. This increase in beetle population followed several years of severe defoliation of larch by the larch sawfly *Pristiphora erichsonii* (Htg.). Since then, the beetle has become widespread in all three provinces and has caused serious tree mortality. By the end of 1981, an estimated 64% of merchantable-size larch were dead in Nova Scotia, 24% in New Brunswick, and 13% on Prince Edward Island. Insect populations have been generally declining since 1984 and the number of trees succumbing to beetle attack has also decreased in most areas.

In 1988, in New Brunswick, dying and recently dead larch trees were more common than during the past few years. Small patches of infested trees, mainly in mature and semimature stands, were present in areas of Charlotte, Queens, Kings, Kent, and Northumberland counties, while scattered newly infested trees, indicating activity by the insect, were observed in Sunbury, York, Carleton, and Victoria counties.

There were no newly infested trees found at the central New Brunswick research plot in 1988. This compares to 7.6% in 1987, 6.7% in 1986, 2.8% in 1985, 3.8% in 1984, and 2.9% in 1983. Cumulative larch mortality due to attack by the eastern larch beetle has increased from 6% in 1979, when the plot was established, to 42% in 1987, an average of 4.7% annual tree mortality during those years.

In Nova Scotia, no eastern larch beetle-infested trees were found.

In Prince Edward Island, affected trees were found at Wellington, Prince County where trees are in various stages of decline in an area of approximately 3 ha.

Gypsy moth

Lymantria dispar (L.)

The gypsy moth has been the most destructive insect of hardwoods and, to a lesser degree, of conifers for decades in the northeastern United States. Female moths are flightless, limiting the spread of this pest to dispersal of the minute early-instar larvae on air currents or to artificial transport as eggs or larvae on human conveyances.

Trapping male moths with pheromone traps has become a common practice throughout Canada. Trapping information is used to help detect the gypsy moth, define where local populations may be found, and to assist the search for other life stages. No moths were trapped in Newfoundland or the prairie provinces in 1988.

Maritime Provinces

After its reappearance in the Maritimes in 1981, the gypsy moth gained further ground in 1988. The gypsy moth appears to be established in both New Brunswick and Nova Scotia and, in 1987, caused visible defoliation in the Region for the first time in nearly half a century. The status of the outbreak in Maine has been of special concern because of its proximity to the Maritimes. In 1988, gypsy moth populations in Maine were low and only some 40 ha of gypsy moth defoliation was recorded.

In the Maritimes, the gypsy moth monitoring committee remained active in 1988, and again coordinated surveys. This committee of many organizations, involving all levels of government, was formed in response to the discovery of gypsy moth in 1981 and was an effort to utilize available manpower more efficiently in combating the threat to the forests of the Region.

In 1988, early season egg-mass surveys, larval surveys, the adult trapping program, and late fall egg mass surveys were conducted to determine the current status of the insect in the Region.

The adult male trapping program is aimed at defining areas where searching for egg masses should be concentrated. As a result of studies since 1980, the trap placement design was changed in 1983 to eliminate, or at least to minimize, interference from large numbers of male moths brought into the Region by weather fronts from infested areas in the United States. Survey traps are now placed in late July. Control traps are also placed at the beginning of July. Data was obtained from 5871 traps in the Region, 2290 in New Brunswick, 3297 in Nova Scotia, and 284 in Prince Edward Island, representing a 93% trap return. The high return, because of better understanding by cooperators of the value of negative results, greatly aided the planning of the fall egg-mass surveys.

The status of the gypsy moth in the Maritimes in 1988 was as follows:

In New Brunswick, gypsy moth egg masses and/or pupae were found during egg-mass surveys at 10 locations. Of these, only three locations are new; however, Scotch Ridge, Greenrock, and Indian Falls are all in the general area of other positive finds. The total number of areas where gypsy moth has been found at least once since 1981 is 47. However, only eight of these areas are outside Charlotte County and, with the exception of Fredericton and Forest City, the gypsy moth has been found only once at these locations.

Over 80% of the known gypsy moth locations in New Brunswick are in Charlotte County, and all 10 areas where gypsy moth was found in 1988 are in the western half of the county or in areas adjacent to it in southwestern York County. In view of the above, the western half of Charlotte County of New Brunswick is considered to sustain a generally low level but widespread population of gypsy moth, both in forest and, at least in the case of St. Andrews, in urban settings. However, the 10 positive locations in 1988 represent less than 4% of the 252 areas searched for egg masses in Charlotte and southwestern York counties, indicating low gypsy moth populations.

In Nova Scotia, gypsy moth was found at 13 locations in seven of the nine counties in the western half of the Province. All but one of the areas were either the same or adjacent to areas where the insect had been found in previous years. The exception was Bridgetown, Annapolis County, which represents a "fill-in" situation, a minor extension in distribution in the Annapolis Valley. Egg masses were not numerous in most areas except at New Minas and Annapolis Royal but even there noticeable defoliation did not occur in 1988. It is worth noting that gypsy moth was not found in several areas, most notably Yarmouth County, where egg masses were present in previous years and that, with the exception of Bridgetown, all positive locations are the same as in 1987.

The gypsy moth has not yet been recorded as established in Prince Edward Island. There were only seven male moths caught in the 284 pheromone traps in the Province. They were all single catches except one and no egg masses were found at any of these locations.

In New Brunswick, most of the gypsy moth locations were in forested areas, away from habitation, and were concentrated in a small section of the Province adjacent to an area of the United States where the insect is known to be present. In Nova Scotia, almost all of the infested spots were inhabited areas. This suggests that, while in New Brunswick the presence of gypsy moth may generally be the result of natural spread, in Nova Scotia the insect was likely imported by commercial traffic, visitors, or residents travelling in gypsy moth-infested areas.

Control operations against the gypsy moth in 1988 were conducted at a number of clearly defined locations. The lead agency listed below for the various programs carried the major responsibility, with assistance at various levels from other cooperating agencies. All pheromone traps were provided by Agriculture Canada. The locations were:

Moores Mills, N.B. - In 1987, at the site of the first high intensity outbreak in the Maritimes in half a century, a cooperative effort was made to reduce, if not eradicate, the population. This effort was followed in 1988 with spring egg-mass surveys, ground spraying with permethrin (Ambush® 500 EC) at a rate of 35 g/ha, aerial spraying of a 130 ha area, (centering around last year's hot spot) with *B.t.* (Futura®, 30 BIU/ha, three applications, a trap-out program, and fall egg-mass surveys.

The larval population following *B.t.* spray was reduced from a pre-spray value of 3.8 larvae/hour-search to a post-spray 0.2 larvae/hour-search. The adult male catch in the trap-out program in 1987 was 3322 males caught in 347 traps (9.6 moth/trap). In 1988, this was reduced to 32 moths caught in 305 traps indicating that, even though total eradication has not been achieved, the population was drastically reduced. Lead agency: New Brunswick Department of Natural Resources.

Mohannes, N.B. - A 257 ha area at the site of the first gypsy moth find in 1981 received three aerial applications of *B.t.* (Futura®; 30 BIU/ha) in 1988. In this area in 1983, 18 ha were clearcut of oak, 102 ha were sprayed with *B.t.*, and over 5 000 egg parasites (*Anastatus disparis*) were released. Extensive annual egg-mass surveys since have served the dual purpose of removing egg masses and obtaining rearing material for parasite recovery rearing. The parasite has never been recovered from this or from neighbouring areas of Maine (thanks to the Maine Forest Service for their cooperation in this project). In the fall of 1988, one fresh egg mass was found in the Mohannes area. The 0.01 egg mass/hour search-ratio indicates very low populations. Lead agency: New Brunswick Department of Natural Resources.

Fredericton, N.B. - A trap-out program in a small area of the city where over two dozen egg masses were found in 1983 was repeated for a third year. The following information indicates that the gypsy moth, if not eliminated, was reduced to sub-detectable levels in the trap-out area (in 1985, the year before the program started, 15 egg masses were found in the trap-out area):

1986 - 650 traps;	231 male moths;	4 egg masses
1987 - 572 traps;	9 male moths;	0 egg masses
1988 - 556 traps;	5 male moths;	0 egg masses

Lead agency: City of Fredericton, with advice from Forestry Canada - Maritimes.

St. Andrews, N.B. - After a few years of "heavy surveys" (<200 traps per location), a trap-out program was initiated in 1988 in the part of the town where egg masses were regularly found. Of the 595 traps placed, 564 were returned. No moths were caught in 329 of the traps but 478 moths were captured in the 235 positive traps. Egg masses (26) were found in the fall. Lead agency: Agriculture Canada, with cooperation from the town.

St. Stephen, N.B. - The trap-out program involved the placement of 430 traps, of which 359 were returned. Sixty traps were negative but 1315 moths were caught in the 299 positive traps. Egg masses (16) were found in the fall. Lead agency: Agriculture Canada with cooperation from the town.

In Nova Scotia only areas where at least 200 traps were placed were considered significant for trapping gypsy moth males. Locations with fewer than 200 traps are considered as "heavy survey", even though the male population reduction effect of these is recognized. For Shelburne 1988 was the third year of the trap-out program. About 500 moths were caught in 388 traps in 1987, similar to results obtained in 1986. Lead agency: Nova Scotia Department of Lands and Forests.

Quebec

The activity of the gypsy moth was restricted this year to Gatineau Park and neighbouring areas. Approximately 1 260 ha were defoliated in this area. In the Eardly escarpment, which forms the southern boundary of the Park, more than 300 ha were 100% defoliated, primarily between the municipalities of Heyworth and Eardly. Red oak, white oak, trembling aspen, and white birch were the primary hosts. Additional small pockets of moderate to severe defoliation were observed from Eardly to Quyon and not far from Mont King. A number of pockets of light to moderate defoliation were also observed along the Gatineau River, between Wakefield and Hull.

The Laurentian Forestry Centre, in cooperation with Agriculture Canada's Plant Protection Division, continued the survey of male gypsy moths between Mont-Saint-Bruno and Quebec City. The areas surveyed are from Saint-Antoine-de-Tilly to Inverness, from Victoriaville to Lotbinière, and in the Drummondville area. The results reveal that an average of 10.8 male gypsy moths were captured per trap this year, compared to 14.7 in 1987, a decline of 26.5%.

Forecast - An egg-mass survey conducted at 10 sites north and west of Hull point to damage in 1989 comparable to that observed in 1988.

Ontario

Defoliation - The total area of moderate to severe defoliation increased from 12 678 ha in 1987 to 29 693 ha in 1988. As usual the largest single area of defoliation (16 089 ha) was mapped in the central Tweed District, much of which occurred in a large infestation along Highway 7 in the Kennebec-Sulphide area (Figure 5). The remainder of the defoliation occurred as a pattern of small scattered pockets in the following areas: southwest Brockville District, western Napanee District, southern Lindsay District, Pembroke District, western Carleton Place District, central Niagara District, and southern Simcoe District. Small numbers of

Figure 5: Occurrence of gypsy moth in Ontario, 1988.

larvae were collected at numerous other locations in southern Ontario, but they did not cause significant defoliation.

Control - Burlap trapping of larvae was carried out at most provincial parks and campgrounds in southern Ontario. In the Eastern Region, larvae were caught at 9 of 13 locations, with the highest catch (1 145) recorded at Sharbot Lake Provincial Park, a decline from the 2 135 larvae recorded last year. In the Algonquin Region, larvae were captured at 7 of 23 locations, with the highest number of larvae at Petroglyphs Park where 600 were captured, up from 22 caught in 1987. Trapping in the Central Region yielded positive results at 11 of 16 locations. The highest catches in this area were at Awenda Provincial Park where the number of larvae increased from 15 to 240 and at Six Mile Lake Provincial Park where the catch increased from 0 to 821 larvae. In the Southwestern Region, larvae were caught at 4 of 11 locations, with the highest number (120) at Turkey Point Provincial Park. Two larvae were captured at Killarney Provincial Park in Sudbury District, a first record for this area.

A gypsy moth pheromone trapping program was carried out in northern and southern Ontario parks for the sixth consecutive year. In southern Ontario, moths were caught at all locations monitored except at Kearney Lake in Algonquin Provincial Park. Minor fluctuations in moth captures were apparent in this part of the province but no trend or pattern was apparent except in Algonquin Park District where numbers were generally lower than those recorded in 1987. In northern Ontario, moth captures were made in 16 parks in the Northeastern Region, mainly in North Bay, Sudbury, and Espanola districts where moth catches have been increasing. Moths were caught at five other locations where negative results were obtained in 1987 as follows: Finlayson Point Park, Temagami District, Rabbit Blanket Lake in Lake Superior Park, Wawa District; Windy Lake and Fairbank Parks, Sudbury District; and Martin River Park, North Bay District. No moths were captured at Fushimi Park, Hearst District and Kettle Lakes Park, Timmins District, where catches were made in 1987.

Forecast - Egg-mass surveys were carried out as part of a spray evaluation program but were too limited to make accurate predictions. However, based on the small amount of data collected and on historical records, it is possible that an increase, possibly two- to threefold in the area of moderate to severe defoliation, may occur in 1989. Late season surveys also disclosed egg masses in a number of previously uninfested areas as follows: Bayham and Blandford townships, Aylmer District; Killbear Provincial Park, Parry Sound District; Bluewater Beach, Tiny Township, Huronia District; at a number of locations in Minden District; and in Silent Lake Provincial Park, Bancroft District. In northern Ontario, a single egg mass was found at Killarney Provincial Park, Sudbury District, and adult moths and two egg masses were found in Prince Township, Sault Ste. Marie District.

British Columbia

About 8000 sticky traps were monitored throughout British Columbia in the thirteenth year of a cooperative program with Agriculture Canada (Plant Health), British Columbia Ministry of Forests, and FIDS. Only 12 adult male gypsy moths were trapped this year in British Columbia in 12 pheromone-baited sticky traps in seven areas. This compares with 216 moths in 56 traps in eight areas in 1987. Male moths were caught near Kelowna (4) and CFB Colwood (1) for the third consecutive year. Male moths were caught near Parksville (2) for the second consecutive year. New catches were made at Point Roberts (2), Coquitlam (1), West Vancouver (1), and at Yard Creek Provincial Park near Sicamous (1). The capture near Sicamous was in one of 291 traps set out by FIDS in 251 forested recreation areas in national and provincial parks, in commercial campgrounds, or near military bases. New egg masses have not yet been found at any of the treated areas, although a couple were discovered at Point Roberts on a ladder recently moved from Ontario.

Bacillus thuringiensis was applied by Agriculture Canada between April 27 to June 14, 1988 at a concentration of 30 BIU/ha in parts of Kelowna, Colwood, and Parksville. At Kelowna and Colwood, aerial applications complemented by ground applications were used over 112 and 40 ha, respectively. Ground-based sprays were used over 4.5 ha at Parksville. The trapping results discussed previously indicated successful control.

Forest tent caterpillar

Malacosoma disstria Hbn.

The forest tent caterpillar again caused moderate to severe defoliation in trembling aspen (Figure 6). Other hosts were also affected. Although outbreaks of this insect can look spectacular, there have been few reports of appreciable tree mortality. The main effect of outbreaks has been reduction in the annual growth of severely defoliated trees. The significance of this reduction is difficult to assess. The affected tree species comprise a major portion of the hardwood volume in Canada, yet a relatively small portion of it is harvested each year. As the utilization and management of aspen intensifies, the impact of aspen defoliators will become more significant.

Newfoundland

Pheromone traps were placed across the Island in camping areas and near towns to collect moths that might be introduced on recreation vehicles from the mainland. Only male moths have been caught in these traps.

Maritime Provinces

Populations were very low throughout the Maritime Provinces and are expected to remain so in 1989 as indicated by light trap catches and pheromone surveys.

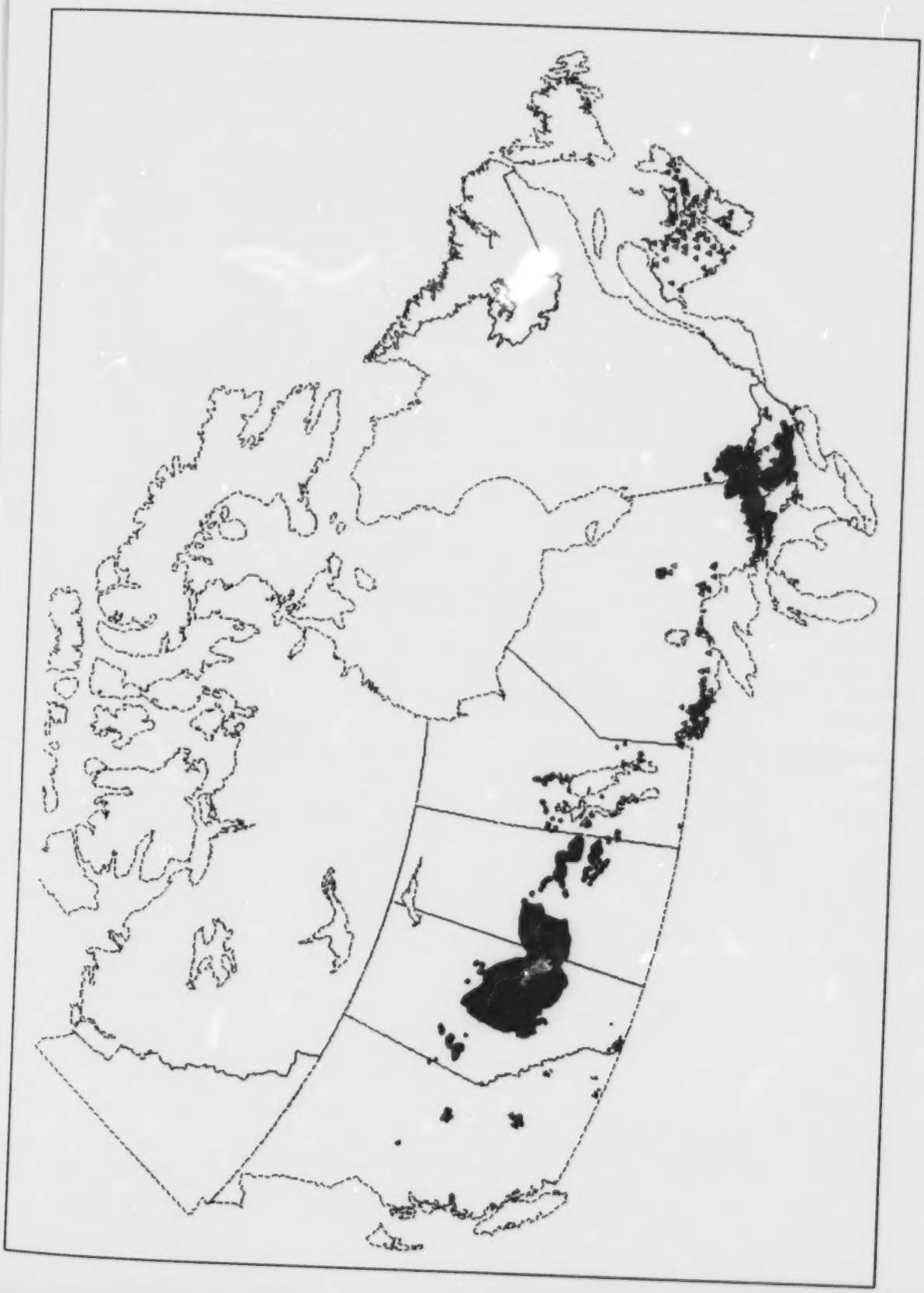

Figure 6: Forest tent caterpillar occurrence in Canada, 1988.

Québec

Forest tent caterpillar populations in Abitibi-Témiscamingue continued to decline in 1988. However, a number of small pockets appeared in the Montreal and Trois-Rivières regions, suggesting a new outbreak.

In Abitibi-Témiscamingue, the main infestation is bounded by Lake Simard to the north, the locality of Laniel to the west, the municipality of Rapides-des-Joachims to the south, and the Dumoine River basin located in the Outaouais Region to the east. Although the total area infested in 1988 exceeds that of 1987, the level of defoliation observed is clearly less severe this year. Roughly 971 600 ha were defoliated in Abitibi-Témiscamingue, an increase of close to 9% over 1987. Pockets of severe defoliation were observed throughout the infested area. Defoliation was observed over 428 750 ha (light) and 458 128 ha (moderate), representing increases of 28% and 5%, respectively, over 1987. At the far south of the infested area, moderate and severe defoliation was reported between Matawa and Rapides-des-Joachims, whereas little or no defoliation was reported last year. Although trembling aspen is the primary host of the forest tent caterpillar in these areas, sugar maple was also damaged.

In the Outaouais Region, in addition to several pockets of light to moderate defoliation near Bristol-les-Mines, the forest tent caterpillar defoliated 116 200 ha in the Dumoine River basin, 16 250 ha severely.

Farther east, scattered pockets of defoliation were reported from the Montreal area to the outskirts of the municipalities of Saint-Michel (census division of Bellechasse) on the south shore and Clermont on the north shore. Although damage was generally light, there were a number of pockets of severe defoliation between Épiphanie and Saint-Grabriel-de-Brandon.

In the administrative region of Trois-Rivières, 2 825 ha of forest composed of stands of aspen and intolerant hardwood species were defoliated. Trembling aspen was the main host. The region of La Tuque was particularly hard hit, with 1 775 ha defoliated. The forest tent caterpillar was also observed in several areas in Saguenay - Lac-Saint-Jean and on the North Shore, near the Portneuf River. However, no significant defoliation was reported in these areas.

Forecast - An egg-mass survey conducted in the fall of 1988 reveals that the forest tent caterpillar will continue to be present in significant numbers in the western part of Quebec and in the Montreal and Trois-Rivières areas. These observations suggest that a new outbreak of forest tent caterpillar may occur in the entire south part of the Province within the next few years.

Ontario

Defoliation - Ground and aerial surveys in 1988 disclosed a total area of 3 965 229 ha of moderate to severe defoliation, an increase from the 1 649 977 ha recorded in 1987.

In northwestern Ontario, defoliation was widespread in the southern parts of the Fort Frances, Kenora, and Dryden districts while sporadic pockets occurred in the central Atikokan and Thunder Bay districts and the southwestern Nipigon District.

In northeastern Ontario, the largest single infestation (1 755 353 ha) stretched the width of the Province from Sault Ste. Marie east to the Quebec border and south into the northern Algonquin Park District. Infestations in the northern Temagami and southern Kirkland Lake districts collapsed as expected in this the oldest part of the outbreak. These declines were somewhat offset by new infestations along several northern rivers in the Hearst District and in the Dubreuilville and White Lake area of Wawa District.

In southern Ontario, a large infestation extended east from Georgian Bay through extensive areas of Parry Sound, Bracebridge, Minden, and Bancroft districts with small extensions into adjacent parts of Tweed, Lindsay, and Huronia districts. Small pockets of defoliation were also mapped in a number of areas of Algonquin Park, Pembroke, Carleton Place, and Owen Sound districts.

Control Operations - In an effort to preserve aesthetic values, the Ontario Ministry of Natural Resources carried out ground spraying operations against forest tent caterpillar in Oastler, Grundy Lake, Arrowhead, and Silent Lake provincial parks in the Algonquin Region and in Six Mile Lake Provincial Park in the Central Region. Futura® FC, a *B.t.* material, was applied by an air-blast sprayer and a mist blower to roadside trees and campgrounds in the parks. An assessment of the program indicates that the four parks in the Algonquin Region received a fair degree of protection and larval reduction; however, results at Six Mile Lake, which was treated last and which supported very high insect numbers, were less successful. Spraying began on May 24th at Silent Lake and was completed on June 2nd at Six Mile Lake.

Forecast - Egg-band surveys were carried out at some 240 locations across the Province during the latter part of the field season. An analysis of results showed that at 198 of these sample locations 82.5% yielded forecasts of moderate to severe defoliation for 1989. Based on these results, and the pattern of previous outbreaks, it is possible that the total area of moderate to severe defoliation could increase to 8 or 9 million ha next year, with increases occurring in the northwestern, northeastern, and southern sections of Ontario.

Prairie Provinces

The forest tent caterpillar was the major defoliator of trembling aspen in the prairie provinces in 1988. It was responsible for defoliation covering a land area of 18 543 036 ha compared to 7 865 103 ha in 1987. A marked increase in the size of infestations was reported everywhere. Most infestations continued within the agricultural and marginal agriculture zones in Alberta and Saskatchewan, but in Manitoba the significant increase occurred in the forested area (Figure 6). The estimated areas of stands of trembling aspen defoliated are given in Table 6.

In Alberta, the overall land area of moderate to severe aspen defoliation more than doubled to 13 830 000 ha in

Table 6. Summary of moderate to severe defoliation of trembling aspen by the forest tent caterpillar in the prairie provinces in 1988

Province	Areas mapped (ha)	Estimated aspen defoliation (ha)
Alberta	13 830 000	2 766 000[a]
Saskatchewan	4 660 200	932 040[a]
Manitoba	52 836	52 826
Total	18 543 036	3 750 876

[a]Estimated as 20% of the total area mapped, as most of the areas surveyed are in the Agricultural Zone.

1988 from 6 610 700 ha in 1987. Within this total land area, moderate to severe defoliation was estimated at 2 766 000 ha. Most of the defoliation was present in the agricultural zones, although considerable infringement on aspen forest regions was reported. Numerous reports of probable virus-infected larval and pupal predation, probably by the flesh fly (*Sarcophaga aldrichi* Park.), were received from the Edmonton-Pigeon Lake area and from the Grande Prairie area.

In Saskatchewan, trembling aspen was defoliated over an area of 4 660 200 ha (Table 6), a marked increase from the 1 250 000 ha reported in 1987. Although a large portion of the defoliated stands remained within the agricultural zones as in the previous season, a further extension of the infestations into forested areas was evident in 1988 (Figure 6). Within the total infestation area, actual aspen defoliation was estimated at 932 040 ha; only 250 000 ha were reported in the previous season.

In Manitoba, a marked increase in aspen defoliation was evident in areas where infestations occurred in 1987. In total, 52 836 ha of moderate to severe damage was reported in 1988 (Table 6) compared to 4403 ha in 1987. Infestations increased in size and intensity mostly in the The Pas-Flin Flon-Snow Lake triangle, near Wabowden, Jenpeg, and along Highway 6 south of Ponton, along the south shore of Dawson Bay, at several scattered locations in the eastern part of the province, and in the Turtle Mountains (Figure 6).

Egg-band surveys were carried out in the three provinces in late fall 1988, and results suggest that the forest tent caterpillar will again cause moderate to severe defoliation in Alberta and Saskatchewan and that there will be increased activity and defoliation in Manitoba.

British Columbia

Severe defoliation of trees and shrubs by forest tent caterpillar was more widespread in 1988 in parts of the Cariboo and Prince George regions and in the East Kootenay. Populations in the West Kootenay and in the Kamloops Region declined. Populations of western tent caterpillar *Malacosoma californicum pluviale* (Dyar) declined in southwestern British Columbia, but were common in the Kamloops and Nelson regions and near Bella Coola for the second consecutive year.

Northwest of Prince George, populations increased for the third consecutive year and defoliated trembling aspen in 120 infestations over 43 300 ha, a fivefold increase from 1987. In the Peace River area, defoliation of trembling aspen and cottonwood declined for the second year to 5000 ha in 15 separate areas, down from 8650 ha in 1987. For the first time in four years, populations in the Cariboo Region increased and severely defoliated trembling aspen over 460 ha in 28 pockets, mostly east of 100 Mile House. In the Nelson Region, population increases resulted in widespread moderate to severe defoliation of trembling aspen over 1500 ha in 24 pockets from Creston to Fernie and north to Donald. Additional pockets of light defoliation varying in size from 0.5 to 5 ha were numerous from Wardner to Golden. Populations in the West Kootenay collapsed following four consecutive years of infestation.

Defoliation of trembling aspen, cottonwood, and other deciduous trees and shrubs is forecast to continue in most recently infested stands near Prince George and Pouce Coupe and from Creston to Donald in the East Kootenay. This prediction is based on overwintering egg samples from 10 areas.

The decline of western tent caterpillar populations in southwestern British Columbia continued in 1988 following infection and mortality of larvae by a nuclear polyhedrosis virus in 1987. Populations in the Okanagan Valley lightly defoliated trembling aspen and roadside shrubs in widely scattered pockets of 0.5 to 4 ha, similar to damage recorded in 1987. For the second consecutive year, alder, birch, and other deciduous trees and shrubs in the Bella Coola Valley in the Vancouver Region were lightly to severely defoliated, most severely near Hagensborg. High numbers of colonies were common on deciduous trees and shrubs in the West Kootenay and, for the first time since 1978, in the East Kootenay.

Hemlock looper

Lambdina fiscellaria fiscellaria (Gn.)

The hemlock looper is native to Canada and occurs from Newfoundland to Alberta, mainly on balsam fir. During an outbreak, however, it will feed on many conifer species and even some hardwoods. Although all eastern provinces have periodic outbreaks, Newfoundland has had regular epidemics.

Newfoundland

Defoliation - The looper continued to be the most important pest on the Island again this year. The annual aerial survey recorded moderate and severe defoliation on about 12 900 ha and light defoliation on about 4 700 ha. Most of these areas were defoliated in 1987 and the reddish discolouration of foliage in these stands was less evident this year. The main outbreak occurred along the west coast (Figure 7), with high larval numbers recorded from the Codroy Valley in southwestern Newfoundland to Roddickton in the Northern Peninsula.

In eastern Newfoundland population levels were high in several small isolated areas in the Avalon Peninsula (Figure 7). No infestations occurred in central Newfoundland.

Figure 7: Areas of moderate to severe defoliation by the hemlock looper in Newfoundland, 1988.

Many of these infestations both in western and eastern Newfoundland collapsed in the later-larval instars due to natural mortality factors, including parasites and disease.

Hemlock looper outbreaks in Newfoundland usually last for 3-6 years and occur at intervals of 10-15 years in stands where mature balsam fir is dominant. The present outbreak began in 1983 in central and eastern Newfoundland and in 1985 in western Newfoundland. The outbreak started to collapse in 1986 in central and eastern Newfoundland, and in 1987 and 1988 on the Avalon Peninsula and in western Newfoundland.

Control Operations - The Newfoundland Department of Forestry conducted an operational control program against the looper and treated 45 138 ha with fenitrothion and 23 788 ha with *Bacillus thuringiensis* (*B.t.*).

Forestry Canada, in cooperation with the province, conducted an experimental spray program testing the effectiveness of new formulations and dosages of *B.t.* and diflubenzuron. Forestry Canada also assisted Parks Canada operations, providing pre-spray and post-spray data in a *B.t.* control program against the looper near camping areas in Gros Morne National Park.

Looper samples were collected from 17 locations in 1988 to assess the level of biological mortality factors. Most larval and pupal parasites were the tachinid flies *Winthemia occidentis* and *Madremyia saundersii*. The incidence of pathogenic fungi was much greater in larval than in pupal samples. *Entomophaga aulicae* was the major fungal disease, while *Erynia radicans*, *Paecilomyces farinosus*, and *Verticillium* spp. also occurred.

Parasitism and fungal disease in late-instar larvae averaged 13% and 33%, respectively, in the older part of the infestation and 1% and 5% in the new parts. Pupal parasitism was 29% and 4% in the older and newer infestations, respectively, while fungi caused about 4% pupal mortality throughout the outbreak.

In addition to the above, 14% and 28%, respectively, of the larvae were infected in the older and new infestations by a fungus tentatively identified as *Aureobasidium pullulans*. This fungus was less common in pupae.

Damage - The aerial survey was completed in early August. Tree mortality was more than 90% in most stands severely defoliated in 1987. The intensity of defoliation in 1988 was not as severe as in 1987 because looper populations collapsed during the late larval instars in most areas. However, additional tree mortality is expected in unprotected stands by 1989.

Forecast - The egg survey commenced in mid-October and branch samples were collected from 561 points throughout the Island. Many samples had no looper eggs, and the outbreak was virtually over. Only two areas, about 10 500 ha in size, are forecast to have moderate to severe defoliation in 1989. These areas are located on the Northern Peninsula, one near Leg Pond and the other near Main Brook.

Light defoliation is forecast for numerous small areas scattered from Bonne Bay to Main Brook on the Northern Peninsula. The egg counts, however, were less than one per branch in most of these areas and defoliation may not become evident in 1989. Light defoliation covering 7000 ha is also forecast to occur in two parts of the Avalon Peninsula

in 1989. An additional 11 200 ha are forecast to have very low larval numbers and defoliation may not become evident.

Maritime Provinces

The hemlock looper, despite its name, is mainly a defoliator of balsam fir in the Maritimes, capable of causing serious damage when populations are high. It feeds on needles of all age classes and is a wasteful eater. Larvae chew off but do not consume all of the needles; consequently a much greater amount of foliage is removed than necessary for their development.

In the Maritimes, populations have been generally low in the past few years. The last serious outbreak occurred in central Prince Edward Island in 1977 and 1978 when the insect killed 80% of the merchantable balsam fir and over 90% of hemlock in the affected area.

In 1988, populations of hemlock looper were low throughout the Maritimes. In New Brunswick one larva was collected from a balsam fir tree in York County. In Nova Scotia, only trace defoliation occurred in the Diligent River-Yorke Settlement area of Cumberland County in stands where defoliation was moderate to severe in 1987 and where a small outbreak had persisted since 1985. In Prince Edward Island, light defoliation occurred on the surviving trees in a forested area near Iris, Kings County, where an outbreak prior to 1987 killed or severely damaged balsam fir and hemlock. Large hemlock trees and a few balsam firs are dying in an approximately 10-ha area north of Granville, Queens County, due to severe defoliation.

Light-trap catches were somewhat higher than in 1987 in southern New Brunswick and in the two national parks in Nova Scotia but much lower in all three traps in Prince Edward Island. Egg-mass surveys in Nova Scotia, conducted by the provincial Department of Lands and Forests, indicate generally low hemlock looper populations for 1989.

Dutch elm disease

Ceratocystis ulmi (Buism.) C. Moreau

Dutch elm disease is caused by the fungus *Ceratocystis ulmi*, which is transmitted chiefly by elm bark beetles. It was accidentally introduced into Canada and, since its discovery in Quebec, has spread over an area stretching from southern Manitoba to the Atlantic Ocean, excluding Newfoundland. All native species of elm are susceptible, including white, red, and rock elms. The disease has caused extensive mortality in eastern North America and will probably become a serious problem in all areas where elms are grown. Few, if any, pests have had as great an impact on shade tree populations in urban areas as has Dutch elm disease. Elms are also valuable timber producing species in some areas and there the disease has had an important effect on the local economy.

Maritime Provinces

Dutch elm disease was a major concern in all three Maritime provinces in 1988.

In New Brunswick, the disease is present wherever elm trees are found. The resurgence of infection reported in 1984 continued, especially along river valleys. Numerous infected and dying trees, both residual old trees and young saplings, were observed throughout the Province in 1988.

In Nova Scotia, the intensification of the disease, evidenced by great numbers of dead and dying elm trees, continued within outbreak areas where no sanitation is practised. No new infections were found outside the known range of the disease in 1988.

In Prince Edward Island, a major change occurred in 1988 in the status of Dutch elm disease. The disease was first discovered in 1979 in a small area of north-central Prince County. The initial discovery was followed by an immediate and vigorous sanitation cut by the provincial government. No infected trees were found in 1980 and 1981, one infected tree was identified and removed in 1982, none were found in 1983 and 1984, one tree was found in 1985 and two trees in 1986. In 1987, infected trees were found at eight locations at widely separated areas of western Prince County. Although the incidence of infection was generally low, there was concern about the spread of the disease in this part of the Province. In 1988 there were few, if any, newly infected trees in western Prince County.

In 1988, the discovery of a newly infected mature elm tree at Alberry Plains, Queens County extended the distribution of Dutch elm disease eastward by approximately 90 km. The infected tree was promptly removed by the owner to minimize the danger of creating a new infection centre in the eastern part of Prince Edward Island.

In Fredericton, the progress of Dutch elm disease and the effects of the control program have been monitored since 1961 when the disease was first found in the city. The 31 trees killed by the disease in 1988 represented 1.0% of the current elm population within the Dutch Elm Disease Management Area. This loss is well in line with the reduction in loss rate since 1980 when it peaked at 7.8%. Annual loss rates during the 1980s are as follows:

1980	7.8%
1981	5.3%
1982	3.0%
1983	2.4%
1984	1.1%
1985	1.3%
1986	0.8%
1987	1.0%
1988	1.0%

Losses to date amount to 29.3% of the original urban elm stand.

No systematic survey was conducted by the Forest Insect and Disease Survey in 1988 for elm bark beetles except in Fredericton, where populations of the native elm bark beetle *Hylurgopinus rufipes* (Eichh.) remained low. The European elm bark beetle *Scolytus multistriatus* (Marsh.)

was not captured in 1988. This insect, the most important vector in spreading Dutch elm disease in the United States has not been a factor to date in Fredericton. Single adults were captured in pheromone traps in 1982 just south of the city and in 1983 at Tay Creek, some 30 km to the north. In 1986 and 1987, single adults were captured on sticky band monitoring traps.

Québec

Dutch elm disease was found at Pointe-Navarre (Gaspé-Est), a first record of the disease in the Gaspé Management Unit. A single tree was infected by the disease at Mistassini River (Saguenay); this is also a new site.

Ontario

Dutch elm disease was found in the Atikokan District, and surveys revealed 7% infection rates in the town of Atikokan. A new distribution point was confirmed when this fungus was identified in the town of Dryden.

Prairie Provinces

In Manitoba, Dutch elm disease surveys were conducted primarily by the Manitoba Department of Natural Resources. A survey was also done with the cooperation of the Canadian Parks Service in Riding Mountain National Park. In the southern part of the province the overall distribution of the disease remained much the same as in 1987, although the incidence of hazard and infected trees in most of the native elm stands continued to cause concern in many locales. In major urban areas, where control programs are maintained, infection remained comparatively low. Less than 1% of the elms in Winnipeg and less than 2% of the elms in Brandon were reported diseased. Most infected trees were found along the banks of the Red, Seine, LaSalle, and Assiniboine rivers between Winnipeg and Portage la Prairie, and west of Brandon to St. Lazare, where a slight northward expansion was reported. Infections continued to be evident along the Souris River south of Brandon down to the United States border.

During 1988, the total identified number of infected trees in Manitoba was 2248, and the total number of hazard and suspect trees scheduled for removal was 17 168.

In Riding Mountain National Park, the disease is well established in the eastern area and now extends to the park's northern boundary.

In Saskatchewan, extensive surveys for the disease and its bark beetle vectors were continued by the Department of Parks, Recreation, and Culture with cooperation from Agriculture Canada's Prairie Farm Rehabilitation Administration (PFRA) and city and town parks departments. No infected trees were found in 1988. Endemic populations of the native elm bark beetle were found at several locations in the province. One adult of the European elm bark beetle was found in a pheromone-baited trap in Regina in 1988, but no diseased elm trees were evident. Eight adults of this species were trapped in 1987.

In Alberta, detection surveys for the disease and its vectors were conducted jointly by Alberta Agriculture (Alberta Special Crops and Horticultural Research Centre) and FIDS (NoFC) in southern Alberta. Pheromone-baited traps and elm trap logs were set out at 16 locations. No evidence of the disease or its two insect vectors was found in Alberta in 1988.

Scleroderris canker

Gremmeniella abietina (Lagerb.) Morelet
(Ascocalyx abietina (Lagerb.) Schläpfer-Bernhard)

Scleroderris canker has been detected in all provinces except Prince Edward Island, Manitoba, and Saskatchewan. This disease of conifers is caused by the fungus *Gremmeniella abietina*. At least two races of this fungus (North American and European) have been determined serologically.

North American race

The North American race of *G. abietina* is widely distributed in Canada and has been a serious problem in nurseries and young plantations for years. Extensive studies of the disease have provided several control recommendations. In eastern Canada the disease is most damaging to pines, especially red, jack, and Scots pines, and often kills them during their first decade of growth. However, once the trees are about 2 m high, they are relatively safe from lethal attack. In western Canada, where lodgepole, ponderosa, and whitebark pines are the principal hosts, the disease has occurred at only a few scattered locations in Alberta and British Columbia. No significant damage has been attributed to this disease in either province.

Maritime Provinces

Scleroderris canker was first found in the Maritimes in 1971. The disease is widespread in New Brunswick, especially in the northern half of the Province and mostly infects plantations of jack, red and Scots pine. In Nova Scotia, where the disease was first found in 1972, a few plantations of red, jack and Scots pine suffered limited lower branch mortality during the mid-1970s. The disease was last found in that province in 1978 and appears to have died out. It has never been found on Prince Edward Island.

After some years of minimal activity, there was an upsurge of new infections in New Brunswick in 1987, likely the result of the ideal weather conditions (wet and cool) during the infection period in 1986.

In 1988, the disease was found in Carleton, Victoria, Madawaska, and Restigouche counties in New Brunswick in a few plantations of jack pine, red pine, Scots pine and in a jack pine seed orchard. Race determination results are not yet available but, all infection being confined to the lower 2 m of the affected trees, no European race is suspected.

Ontario

Several heavy infections of the North American race of the disease were encountered in 1988. In Houghton Township, Blind River District, 67% of 2.3 m r.d pine were infected, 15% severely with 2% mortality. An infection rate in excess of 90% was recorded on 4-m jack pine in Smilsky Township, Sault Ste. Marie District and 27.3% of the trees were infected in a 5-ha red pine plantation in Olrig Township, North Bay District. Trace and light infection levels were recorded on young jack pine stands in a few locations in Geraldton, Nipigon, and Sioux Lookout districts.

European race

In 1975 a disease syndrome different and more serious than that normally associated with scleroderris canker in North America was reported in New York State. The disease was killing large pine trees and was serologically identified as the European race of *G. abietina*. It has since been detected at scattered locations in Newfoundland, New Brunswick, Québec, and Ontario. Except in Newfoundland, the symptoms and damage caused by the European race have been indistinguishable from those of the North American race.

Newfoundland

All Sitka spruce plantations on the Island were surveyed in 1988 for scleroderris canker and suspected trees were sampled for the disease. Only the plantation near Roddickton, where the disease was first recorded in 1985, had typical symptoms of infection.

The incidence of scleroderris canker continued to increase in and around St. John's with three new locations recorded.

The infection of Scots pine recorded in 1987 in an old forest nursery on the Salmonier Line was confirmed this year. The disease was also recorded in 1988 in a Scots pine plantation at Colliers Ridge on the Avalon Peninsula.

Staff of the Newfoundland and Labrador Region organized a field trip to assess the status of scleroderris canker in Newfoundland. Personnel from the Newfoundland Department of Forestry, Agriculture Canada, and the Laurentian Forestry Centre of Forestry Canada participated. Many Sitka spruce and pine plantations were inspected and the presence of disease was confirmed in all locations previously recorded.

Maritime Provinces

The European race, and several "intermediate" races, have been found in New Brunswick at 11 locations since 1978, but none later than 1981. The disease had been eradicated at three of the 11 locations even before the final race identifications were available. "Controlled" status has been achieved by the pruning of branches to 2 m from the ground at two locations, one in 1985 and one in 1987. In 1988, two more plantations in northeastern New Brunswick were brought under "control" by pruning, the work being done by the Department of Natural Resources. The remaining four locations are "under surveillance", in that an annual inspection is conducted for symptoms and changes in symptom expression. Where present, branches with symptoms are cultured and tested to determine the appropriate race of the fungus. *Gremmeniella abietina* was isolated from samples at three of these four locations in 1988. Results of race determination are not yet available, but no non-North American race of the fungus has been found at any of these locations since 1981.

Québec

During the special scleroderris canker detection program conducted in 1987 in parts of the Eastern Townships, the European race of this fungus was identified at 64 plantations. In 1988, regular visits to these plantations enabled identification of 51 plantations where control activities would be desirable. Sanitation treatments were carried out on these plantations in the summer.

In 1988, 413 plantations were visited as part of the scleroderris canker detection program: 157 in the Eastern Townships and 256 in the south part of the Quebec City Region. Samples from 2 diseased trees were collected from each infected plantation in order to increase the possibility of isolating the European race.

The canker was detected in 26 plantations in the Eastern Townships and 117 plantations in the Beauce, where 25 and 61 plantations, respectively, were affected by the European race. Race determination was done by the Laurentian Forestry Centre. Of these plantations, at least 12 contained both races of *G. abietina*.

The results of a quantitative evaluation of 100 plantations revealed that there were five plantations in which more than 25% of the trees showed symptoms of the disease, 26 plantations in which 6% to 25% of the trees were affected, and 69 plantations in which less than 6% of the trees were affected. In 1989, pruning will be done in plantations affected by the European race and in plantations where at least 6% of the trees were affected by the North American race.

1989 Detection Program - The target sectors for 1989 are the Outaouais and Montreal regions, where an evaluation program was conducted in 1984. Work at the Beauce Management Unit will also be completed.

Ontario

An intensive, widespread program of aerial and ground surveys is carried out annually to determine the status of this disease at known infection centres and to detect new infection centres. To date infection centres have been detected in Mayo Township, Bancroft District, Macaulay Township, Bracebridge District, and the adjacent townships of McMurrich and Ryerson in Parry Sound District. During the 1988 field season new infection centres, confirmed by serological testing, were discovered on single red pine plantations in May and Ryerson townships and in two locations in McMurrich Township, one of which was infected two years ago. All the new finds were close to known

infection centres and do not represent any significant extension in the distribution of this pathogen.

European larch canker

Lachnellula willkommii (Hartig) Dennis

Maritime Provinces

European larch canker was first discovered in the Maritimes in 1980. Surveys since then have established the distribution of the disease as widespread in southeastern New Brunswick and on mainland Nova Scotia. European larch canker has been a serious disease in many parts of Europe. The fungus is generally considered to be a primary pathogen (capable of infecting vigorous, healthy trees) and its presence has resulted in the exclusion of larch from plantation programs in parts of Europe. In North America, the fungus was first found in Massachusetts in the 1920s in European larch plantations. Periodic concentrated eradication attempts appeared to have been successful, as the disease was not found during surveys of the area in 1965. However, it was discovered in northeastern Maine in 1981.

The fungus mostly infects young trees; therefore, future wood supplies may be affected. Tree mortality reduces stocking, branch mortality reduces growth, and cankers reduce wood quality. The extent to which the disease will cause damage in the Maritimes is not yet known but the potential for damage is there and the role of the disease will have to be considered in view of the increased emphasis on forest renewal and larch tree improvement programs.

In 1988, the disease was not found outside the range of the known distribution during surveys of 100 locations, 23 in New Brunswick, 68 in Nova Scotia, and 9 in Prince Edward Island (Figure 8). Of 26 locations examined within the quarantine zone in southeastern New Brunswick, infected trees were found in six areas, the incidence ranging from 4% to 32%. In Nova Scotia, larch was found to be infected at four of the 15 locations examined within areas of the known distribution. The Nova Scotia surveys included 20 plantations of eastern, European, Japanese, and Siberian larch, all of which were found free of the disease. European larch canker is not known to be present on Prince Edward Island.

Investigation of several aspects of the behaviour of the fungus under our climatic conditions has been initiated. Results will be reported as they become available. A survey to establish age and spread pattern indicates that the fungus could have been present in the Maritimes for about two decades before its discovery and may have spread from specific areas. The study also showed a rapid decrease in incidence of infected trees with increasing distance from the Bay of Fundy, possibly indicating a climatic dependence.

The disease is capable of intensifying rapidly in young stands. Incidence of infected trees in a research plot increased as follows, based on fall assessments: 1982 - 7%, 1983 - 19%, 1984 - 46%, 1985 - 88%, and 1986 - 91% of

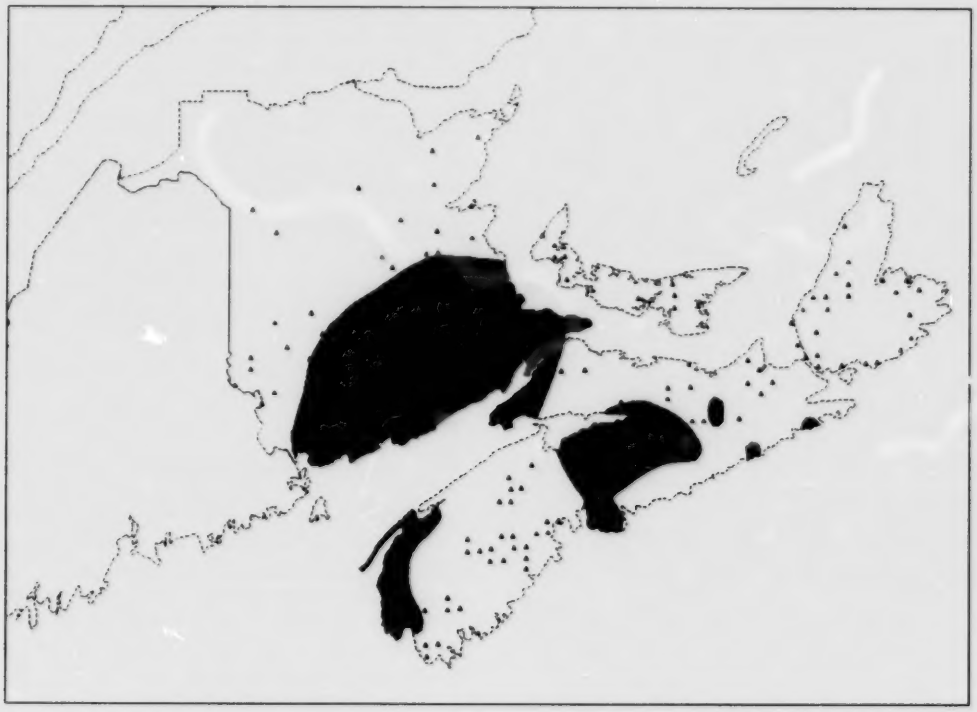

Figure 8: Distribution of European larch canker in the Maritimes, 1988.

trees affected. Considering the high level of incidence, this study was terminated at that point.

Greenhouse-grown seedlings of 22 populations of *Larix decidua*, *L. leptolepis*, *L. eurolepis*, *L. laricina*, and *L. sibirica* were successfully planted in a heavily infected area in the early summer of 1983 to test differences in susceptibility to infection. *Larix occidentalis* seedlings were added to the test in 1985. Cankers, bearing fruiting bodies of *Lachnellula willkommii*, were found on three *L. decidua* seedlings in the fall of 1984. By the fall of 1985, 11 of the 24 living larch populations had at least one seedling infected by the disease. The species affected were *L. decidua*, *L. leptolepis* and the native tamarack, *L. laricina*. Two additional larch populations became infected in 1987. One of these represents the first infection of *L. eurolepis* in the study. Additional seedlings of already affected populations became infected both in 1986 and 1987. No information is available on the 1988 results.

Decline, dieback, and stress-related disorders

Maple Dieback and Decline

Much has been said and written in recent years about the sugar maple decline affecting vast areas of eastern North America, especially Quebec, and about its effects on the maple syrup industry and other forestry-related activities. The reasons for this decline are still not definitively known in spite of the large, international research effort undertaken to determine the cause. Maple dieback, as it is often known, appears to be associated, at least in some instances, with the deterioration of other hardwoods.

Maritime Provinces

In New Brunswick, in 1986, surveys identified some sugar maple stands in deteriorating condition but no widespread decline was found. In 1987, an aerial survey was conducted over much of the province, covering parts of York, Carleton, Victoria, and Madawaska counties, in order to gain a better overview of where declining stands may exist. This area was selected partly to follow up on results of the 1986 survey, and partly because of its proximity to Quebec and the northeastern United States. The survey was a cooperative effort of the Forest Insect and Disease Survey and the New Brunswick departments of Natural Resources and Municipal Affairs and Environment.

Decline in stands of sugar maple exists in some parts of New Brunswick; however, as reported in 1987, the pattern of the deterioration is discontinuous, is of variable intensity, and its cause is often known or is explainable.

The North American Sugar Maple Decline Project (see section on Special Surveys), a major 3-year international, interprovincial program, was launched in 1988. It was designed to help understand the possible causes of maple decline in eastern North America. A joint program of Canada and the United States, the project involves four eastern provinces and seven eastern states, with workers from federal, provincial, and state agencies, as well as from universities. The objectives are (1) to examine change in sugar maple condition over a large geographical area and (2) to relate change, if possible, to levels of atmospheric pollution. Assessments include both managed sugar bushes and unmanaged stands at various levels of initial stand condition. Over 100 plots were established in the United States and over 60 plots in Canada.

In the Maritimes, 10 permanent plots were established in New Brunswick and two in Nova Scotia. All plots were assessed according to standardized protocols and the information was submitted to a central data bank for analysis. Assessments were a cooperative effort of personnel from Forestry Canada - Maritimes, the New Brunswick Dept. of Natural Resources, the New Brunswick Dept. of Municipal Affairs and Environment, and the Nova Scotia Dept. of Agriculture and Marketing. Data are not yet availab[illegible].

Québec

Since it was first reported in the late 1970s in the Beauce, Eastern Townships, and Bois-Francs regions, maple decline has gradually spread and now covers Québec's entire hardwood forest. Aerial surveys conducted by the provincial Service de la protection contre les insectes et les maladies from 1983 to 1987 indicate that half of the areas covered by maple stands surveyed during those years (2 million ha) showed symptoms of decline. Of this affected area 47% was in the light decline class (11% to 25% of missing foliage). The surveys also revealed that the regions most severely affected by the phenomenon are located in the southern part of the province.

Results of studies conducted by the Service de la recherche appliqée also reveal that the number of trees affected is constantly growing. A network of 256 semi-permanent study plots established since 1983 in the entire hardwood region of Quebec — from Témiscamingue to Matane — makes it possible to monitor changes in the phenomenon. In 1986, 76% of trees were affected. In 1987, this figure increased to 84.7% and, in 1988, to 88.9%.

The studies are also used to determine the severity of the phenomenon, in terms of the percentage of defoliation. The results for 1988 reveal that the amount of foliage appears to have stabilized, or even increased slightly, in the last growing season. The percentage of missing foliage was 23.8% in 1986, 28.1% in 1987, and 26.5% in 1988.

In the summer of 1988, study plots established in 1983 were remeasured and the same exercise will be conducted in 1989 for the plots established in 1984. This will allow determination of the growth of stands on the basis of the different rates of decline and to assess this decline, including trees that were too small to be included 5 years ago but have grown to an acceptable size today. There are also plans to re-analyse the soil at these study plots in order to determine whether there have been any changes in the nutrient cycle.

Work on forest decline revealed that the maple stands affected by decline have mineral deficiencies. Fertilization

experiments, particularly those conducted by Dr. B. Bernier from Laval University, largely corrected imbalances in the nutrient status of the stands. Following the experiments, a semi-operational fertilization program was developed in order to extend the scope of the results. In 1988, 86 maple stands in the Appalachians and 10 maple stands in the lower Laurentians were fertilized following sampling and foliar analyses conducted the year before. This program has now been extended to all regions of Quebec. In August 1988, 235 new maple stands located throughout the range of the maple were sampled and will be fertilized in the spring of 1989.

This semi-operational fertilization program will serve as the basis for an operational program announced last fall by the provincial and federal governments. This program will be implemented by the spring of 1989 in sectors where data on the nutrient status of the maple stands permit, that is, in large sectors of the Appalachians.

Ontario

In 1987, the FIDS Unit established seventy 25-tree plots to monitor the condition of sugar maple throughout its range in Ontario. An additional 10 plots were added in 1988, bringing the total number of plots to 80 with 2000 trees examined. An analysis of results showed 88.3% of the trees were healthy, 10% showed minor dieback symptoms, 1.5% displayed moderate to severe dieback symptoms, and 0.2% were dead. This rate of deterioration is considered normal in stands of these age classes.

In addition to the above, the Ontario FIDS Unit also participated in the North American Sugar Maple Decline Project. Some 24 plots were established throughout the range of sugar maple in the province, 12 each in managed sugar bushes and in undisturbed forest stands. A number of parameters relating to site and stand conditions were measured and recorded, along with data on the current condition of each tree. These data will be analyzed to determine the rate of change in the condition of sugar maple from 1988 through 1990.

Red Oak Decline

Ontario

Re-evaluation of the southern Ontario oak decline plots (for which 12 years of data are available) yielded the following results. Approximately 88% of the trees showed nil to light dieback symptoms, 1.8% of the trees displayed moderate to severe decline, and 9.9% of the trees were dead. These figures represent only minor changes from those recorded in 1987.

Special Surveys

Cone and seed pests

The establishment of seed orchards created a new category of high value areas in the Maritimes Region. Seed orchards and seed production are as important to nursery programs as seedling production in nurseries is to plantation programs. Consequently, anything that interferes with seed orchards also affects most other phases of forestry operations aimed at future wood production. Forest pests in seed orchards, both insects and diseases, have the potential to seriously affect seed production, either directly, by destroying seed or cones, or indirectly, by affecting the condition of trees, thus interfering with their ability to produce seed.

Maritime Provinces

There was a heavy cone crop throughout the Maritimes in 1988. Cones, seeds and orchard trees were examined in greater detail for damage than in previous years, due partly to the abundance of cones, to the increasing expertise of seed orchard staff in problem recognition, and to the existence of a contract for developing pest monitoring systems jointly funded by the Canada/New Brunswick and the Canada/Nova Scotia Forest Resource Development Agreements.

Insects - Spruce cone maggot, *Strobilomyia neanthracina* [*Hylemya anthracina* (Czerny)] damage was found in most white spruce orchards in Nova Scotia but this was usually on isolated trees and at fairly low levels. Coneworms, *Dioryctria* sp., were found in small numbers on spruce, jack pine, and larch at various seed orchards in the Maritimes Region. The spruce budworm, caused moderate to heavy cone losses in one black spruce seedling seed orchard in New Brunswick. A single larva of the Zimmerman pine moth, *Dioryctria zimmermani* (Grt.), girdled the 5 cm stem of a jack pine tree in a New Brunswick seed orchard. Spruce bud scale, *Physokermes piceae* (Schr.), damage was severe on a few black spruce at a New Brunswick seed orchard and light on red spruce at a Nova Scotia orchard.

Insects that affected orchard trees, but did not directly affect seeds or cones, were as follows: a budmoth, *Zeiraphera* sp., light on white spruce at a Nova Scotia orchard; spruce budmoth *Zeiraphera canadensis* Mut. & Free., trace on white spruce at another Nova Scotia orchard; larch casebearer, *Coleophora laricella* (Hbn.), light on larch at a New Brunswick seed orchard; spruce bud midge *Rhabdophaga swainei* Felt, typically trace on spruce but light at one New Brunswick orchard; a tip beetle, probably *Conophthorus banksianae* McP., present on a few jack pine at a New Brunswick seed orchard; orange spruce needleminer *Coleotechnites piceaella* (Kft.), present on black spruce in one New Brunswick orchard; a cutworm, probably *Anomogyna* sp., feeding in small numbers on male spruce flowers at a New Brunswick seed orchard; a leaf beetle, *Syneta extorris borealis* Brown, present on jack pine at a New Brunswick orchard; European pine shoot moth *Rhyacionia buoliana* (D. & S.), common on red pine buffer trees around a Nova Scotia seed orchard.

In general, infestation levels of aphids and mites were reduced from last year throughout seed orchards in the Maritimes Region, probably because more rain in 1988, especially in Nova Scotia, created conditions less favourable for these pests than last year's hot dry summer.

Populations of Tetranychidae spider mites remained moderate to high in red spruce at one Nova Scotia seed orchard but, overall, the severe spider mite problems reported throughout the Maritimes in 1987 declined sharply in 1988.

Aphids, including *Cinara* spp., the eastern spruce gall adelgid *Adelges abietis* (L.), the ragged spruce gall adelgid *Pineus similis* (Gill.), the spruce twig aphid *Mindarus obliquus* (Cholodk.), and the pine leaf adelgid *Pineus pinifoliae* (Fitch) were present throughout Maritime orchards but only at very low levels. In one Nova Scotia seed orchard, *Cinara* sp. appeared to be more common on fertilized red spruce than on adjoining unfertilized trees.

Diseases - The spring and early summer of 1988 was cool and damp for most of the Maritimes. This provided conditions deemed conducive to the development of many of the diseases affecting orchard trees, cones, and seed. With 1988 being a 'bumper' cone crop year, cone- and seed-borne diseases were particularly evident.

Sirococcus shoot blight *Sirococcus conigenus* (DC.) P. Cannon & Minter was collected on white spruce cones at 13 Nova Scotia locations (of 17 locations sampled). The average number of infected cones was 22.1% (range from 3 to 73% infected).

Scleroderris canker was present again at high levels in a New Brunswick jack pine seed orchard. Lower-limb pruning of infected trees was carried out in 1987; the effects of the control should be noticeable by 1989.

Spruce needle cast *Pucciniastrum americanum* (Farl.) Arth. was present in all white spruce orchards in the Maritimes, although mostly at low to trace levels. In two Nova Scotia seed orchards, 49% and 67% of the white spruce cones, respectively, were affected. The level of infection per cone, however, was low and only minor seed loss occurred. Cones collected from stands in Nova Scotia were also infected; the level of infection from 17 locations ranged from 1% to 100% of the cones, with five locations negative for rust. The average number of infected cones was 31.4%. At a stand in the Cape Breton Highlands, all cones were infected, with 36% being a total loss due to multiple rust infections per cone.

Spruce cone rust, *Chrysomyxa pirolata* Wint., was found only on a few spruce cones at seed orchards throughout the Region.

Armillaria root rot *Armillaria mellea* (Vahl ex Fr.) Kummer was found on a few trees in a black spruce family

test in Nova Scotia and in one and three black spruce seed orchards in Nova Scotia and New Brunswick, respectively.

Needle rusts on various hosts were present but in insignificant amounts. Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka was again a problem in several jack pine seed orchards in New Brunswick. Removing galls by pruning infected limbs was done in three seedling orchards and one clonal orchard.

Abiotic causes - Frost caused considerable damage to young developing female cones in a white spruce seed orchard in Nova Scotia and light damage in another. The terminal portions of many cones were killed (10% to 30% of the affected cones), resulting in a concomitant loss of seed from the damaged scales.

Winter desiccation, usually of rootstock foliage only, was evident in white and red spruce grafts in two Nova Scotia orchards. Snow damage was light on white spruce and trace on tamarack in a New Brunswick seed orchard.

Mouse damage, resulting in the loss of several hundred grafts of both white and Norway spruce, occurred in a Nova Scotia orchard where rodent damage had never occurred before. The combination of an early snow cover in the fall of 1987, the resulting lack of ground freezing, and some site preparation work (white spruce only) probably contributed to the rodent population explosion in the orchard.

Animal damage, in the form of feeding by porcupines and deer, was present in several tamarack orchards in New Brunswick. Minor stem scarring by deer occurred in one white pine orchard in Nova Scotia.

Ontario

Surveys for cone and seed pests in 1989 were focused on jack pine in northern Ontario and red pine in southern Ontario.

Jack Pine - Each ranger collected 100 mature but still green cones, and these were submitted to the Sault Ste. Marie laboratory for dissection and analysis. A total of 900 cones were thus examined. Damage at different locations varied from 2% to 48% of the cones with an average of 15.1%. Average seed loss within damaged cones was 29.5%. The principal agents causing the damage in order of importance were as follows: unknown lepidoptera, unknown agents, a coneworm *Dioryctria* sp., the northern pitch twig moth *Petrova albicapitana* (Busck), a midge *Resseliella* sp., the fir coneworm *Dioryctria abietivorella* (Grt.), and the eastern pine seedworm *Cydia toreuta* (Grt.). The larvae of the northern pitch twig moth normally feed on bark and wood of branches from within a nodule of pitch. Sometimes, however, the nodule is constructed next to a developing cone and the larvae enter the cone, where they mine through scales and destroy seeds.

Red Pine - The methodology for the southern Ontario red pine cone survey was the same as that described above for jack pine. A total of 500 cones were submitted and analysed and, of this total, 295 or 59% were damaged. The average seed loss within damaged cones was 67.8%. The principal agents causing damage were as follows: unknown agents, unknown lepidoptera, the red pine cone borer *Eucosma monitorana* Heinr., a midge *Resseliella* sp., the Zimmerman pine moth *Dioryctria zimmermani* (Grt.), the red pine cone beetle *Conophthorus resinosae* Hopk., the fir coneworm *Dioryctria abietivorella*, and the eastern pine seedworm *Cydia toreuta*.

British Columbia

Cone crops in British Columbia were generally good in 1988 . Douglas-fir, grand fir, and cedar crops were heavy on eastern Vancouver Island but generally moderate in the interior. Interior spruce cone crops were heavy but seed yield was severely reduced due to infection by inland spruce cone rust *Chrysomyxa pirolata* Wint. Lodgepole and ponderosa pine crops in the interior were good.

Twelve coastal and five interior seed orchards were surveyed. Cooley spruce gall adelgid *Adelges cooleyi* (Gill.), infested Douglas-fir again at six coastal orchards, Sitka spruce at two orchards, and white spruce at one interior seed orchard. Balsam woolly adelgid *Adelges piceae* (Ratz.), lightly to moderately infested twigs on amabilis fir at two orchards near Victoria that are within the infestation regulation zone. Eighteen percent of the immature yellow cedar cones in a coastal seed orchard were infested by a gall midge *Contarinia* sp., for the second consecutive year. Pine needle sheathminer *Zelleria haimbachi* Busck, was common in low numbers in new shoots of lodgepole pine at four interior orchards.

Spruce cone crops were affected by several important pests, including inland spruce cone rust, which infected cones at 20 locations in the Prince Rupert Region. Spruce cone rust was also present to a lesser degree in the Nelson and Prince George forest regions. Infection was most severe in the northern part of the Prince Rupert Region where 50% to 100% of the cones were infected over a widespread area. Infection averaged 16% at six sites in the interior part of the Prince Rupert Region, 8% at five sites in the Nelson Region, and 7% at two sites in the Prince George Region. The spruce cone maggot *Strobilomyia neanthracina* Michelsen [= *Lasiomma anthracina* (Czerny)] destroyed over half of the seeds in 32% of the white, Engelmann, and Sitka spruce cones at 52 sites in five forest regions. The proportion of cones that were affected ranged from 10% in the West Kootenay to 55% in the Prince George Region. Spruce seed moth *Cydia strobilella* (L.) infested an average of 21% of the spruce cones at 14 sites in four forest regions; the level of infestation ranged from 15% in the eastern part of the Cariboo Region to 45% in the Prince George Region.

Douglas-fir cone crops in the interior and parts of the lower mainland were infested by two major seed pests and a coneworm. Douglas-fir seed chalcid *Megastigmus spermotrophus* Wachtl. infested and destroyed seed in an average of 20% (range 12 to 24%) of the Douglas-fir cones at 10 locations in the Kamloops Region and in the East Kootenay. An average of 8% of the cones were mined and destroyed by fir coneworm *Dioryctria abietivorella* (Grt.) which inflicted the most damage at Indian Gardens west of Kamloops. Seeds in 5 to 20% of the Douglas-fir cones at 15 locations in the southern half of British Columbia were destroyed by Douglas-fir cone moth *Barbara colfaxiana* (Kft.); damage was most severe in the East Kootenay and in

the Okanagan Valley. A pine cone borer *Eucosma recissoriana* Heinr. infested up to 30% of the lodgepole pine cones in two of four stands sampled in the western part of the Prince Rupert Region.

Stillwell's Syndrome

Balsam fir trees stressed by repeated spruce budworm defoliation are susceptible to attack by numerous organisms that are normally considered to be of secondary importance. Investigations in 1982 into the possible cause of Stillwell's syndrome found that all red trees sampled were affected by Armillaria root rot and at least one species of beetle. Balsam bark weevil *Pissodes dubius* Rand was present in 75% of the affected trees, balsam fir bark beetle *Pityokteines sparsus* (Lec.) in 17%, and sawyer beetle *Monochamus* sp. in 17%. Observations elsewhere indicate that not all Stillwell's syndrome-killed trees are affected by Armillaria root rot, that balsam bark weevil and balsam fir bark beetle frequently occur together on the same tree, and that sawyer beetle attack of weakened living trees is not uncommon.

Maritime Provinces

In 1988, the number of trees affected by Stillwell's syndrome was generally low, but mortality occurred throughout the three provinces. In New Brunswick, the distribution of newly killed trees was very uniform; in Nova Scotia, dead trees were more numerous in Colchester-Cumberland counties, the area of the most recent spruce budworm outbreak. In Prince Edward Island, where mortality was higher than last year, numerous trees were killed in an area of about 10 ha at Iris, Kings County, where hemlock looper has defoliated trees in recent years. Mortality was also common along the Montague River in Kings County, at Hampshire, Queens County and at Mount Royal, Prince County. At Belfast, Queens County, four white spruce trees died of Stillwell's syndrome.

Québec

In 1986, the results of a special survey were reported on the sudden reddening of isolated firs or small groups of firs in a number of softwood stands in Quebec. This survey revealed that these trees had been killed quickly by a severe attack of one or more species of bark beetles or other wood borers.

To monitor the evolution of this phenomenon, three semi-permanent study plots were established in stands where damage was relatively severe. The first site was established near Joliette in a balsam fir stand that had been hit by an ice storm in the fall of 1983. The two other sites were established in stands that had been severely affected by a spruce budworm: one close to Lake Laflamme in the Montmorency Forest in the Laurentian Reserve and the other near Trinité-des-Monts (Rimouski). The main data from this monitoring program appear in Table 7.

In 1988, a slight increase was observed in tree mortality at Lake Laflamme and at Trinité-des-Monts compared to the stand at Joliette, where mortality increased by 11.4%. This is probably a direct result of the high level of insect activity at this site in 1987, where close to 70% of the trees sampled showed resinosis on four or more places per tree. These bark miners and wood borers appeared to be still relatively active at Lake Laflamme in 1988, an indication that the stand under study continues to be under major stress.

In the fall of 1986 and spring of 1987, sections of tree trunks that had reddened or showed a high level of activity by the types of insect mentioned above were referred to the Laurentian Forestry Centre for further study. A number of logs were analysed and others were placed in cages to capture the insects and parasites that emerged from them. These samples came from Trinité-des-Monts and the Montmorency Forest. Nine trees providing 26 logs were studied. A list of the major insects gathered in this study is provided in Table 8.

Table 7. Condition of balsam firs in three study plots in Québec infested by bark miners and wood borers

Location	Year of observation	Number of trees studied	Dead trees	Percentage of trees studied Number of resinosis per tree			
				0	1-3	4-10	11 & over
Joliette	1986	70	15.7	40.0	21.4	20.0	2.9
	1987	70	18.6	1.4	8.6	30.0	41.4
	1988	70	30.0	8.6	31.4	25.7	4.3
Lac Laflamme	1986	87	11.5	44.8	17.2	10.4	16.1
	1987	87	19.5	27.6	28.7	9.2	15.0
	1988	87	21.8	18.4	23.0	16.1	20.7
Trinité-des-Monts	1986	72	22.2	34.7	25.0	7.0	11.1
	1987	72	22.2	30.6	25.0	11.1	11.1
	1988	72	26.4	43.1	19.4	6.9	4.2

Table 8. List of insects collected in the study of reddened fir logs in Québec

Insects directly associated with the reddening of fir trees	
Coleoptera (bark beetles and wood borers)	
Monochamus scutellatus (Say)	Whitespotted sawyer
Pissodes dubius Rand.	Balsam bark weevil
Pityokteines sparsus (Lec.)	Balsam fir bark beetle
Trypodendron lineatum (Oliv.)	Striped ambrosia beetle
T. rufitarsus Kby.	Conifer ambrosia beetle
Hymenoptera (wood borers)	
Sirex spp.	
Probably *S. cyaneus* F.	Blue horntail
and *S.j. juvencus* (L.)	European blue horntail

Nursery and greenhouse pests

Successful seedling production is essential to avoid or at least to minimize the shortfalls in wood production predicted to occur in the future. Seedling production is as important to plantation programs as seed production is to nurseries. Pests affecting nursery production increase the cost of meeting the objectives of forestry.

Of the conditions encountered in 1988 in nurseries and greenhouses, some are mentioned here because of their importance, while others demonstrate that no facet of forestry is without problems. Although the insects and diseases mentioned may appear insignificant, they did occur in spite of constant vigilence and continuing control measures. Good nursery practices have limited their damaging potential.

Maritime Provinces

Abiotic problems were widespread and severe in 1988. Considerable seedling losses occurred and many "surviving" trees were injured to some extent.

Diseases - The gray mold *Botrytis cinerea* Pers. ex. Fr., was heavy on 1.5 million 1-year-old jack pine container stock overwintered at a New Brunswick nursery. The cold spring weather allowed snow to persist and provided ideal growing conditions for the mold on the seedlings. This crop was treated at planting to minimize disease spread. Elsewhere, gray mold was very common as a secondary infection whenever seedlings were stressed or injured by abiotic problems between seed germination and their outplanting.

Sirococcus shoot blight was not reported from forest nurseries in the Maritimes in 1988.

The smothering fungus *Thelephora terrestris* Ehrh. ex Fr. was present among 2-0 black spruce container stock in the holding area of a Nova Scotia nursery. These large seedlings provided ideal conditions under their dense foliage canopy for both smothering fungus on the soil surface and the gray mold on the suppressed branches.

Two cup fungi, a *Plicaria* sp. and *Peziza repanda* Pers., were common among white spruce and black spruce, respectively, at two separate forest nurseries in New Brunswick. The *Peziza* was large enough to obstruct some water from reaching the soil in solid wall containers, but otherwise they were not harmful.

A needle rust *Coleosporium asterum* (Diet.) Syd. occurred at trace levels on about 2000 potted red pine in the holding area of a New Brunswick nursery.

Insects - A cutworm, probably a *Polia* sp., caused damage to a 16-week-old crop of black spruce at a New Brunswick container nursery.

The strawberry root weevil *Otiorhynchus ovatus* L. was present in a Nova Scotia container nursery, but it appeared to be controlled.

Abiotic factors - The actual number of seedlings lost in forest nurseries in the Maritimes during the year is not known. However, there were unreported losses of crops involving large numbers. These losses are often caused by human-caused abiotic problems and are greater than losses to insects and diseases combined. Many of these problems could be prevented by better management and cultural practices.

One principal cause of abiotic injuries has been raising seedlings too big for the container. This condition results from inappropriate scheduling of container crops in relation to planting seasons. When the crop continues to grow, the resulting oversized seedlings are prone to a variety of problems including deterioration of shaded foliage, root dieback, and establishment of diseases like gray mold. Then the protection of such crops requires use of pesticides and good luck in terms of climatic conditions that do not favour spread of pests. Disfigured crops may not do well in plantations and, consequently, poor performance and additional mortality can be expected.

Abiotic problems also included poor root development, watering problems, overwintering injury, fertilizer burn, and frost damage, alone or in combination. The impact of non-lethal abiotic injury on plantation establishment is difficult to measure but should not be minimized or overlooked. For example, significant losses occur when apparently healthy seedlings are outplanted and fail to become established when exposed to normal moisture stress in new plantations.

Prairie Provinces

In Alberta, two new potential pests were identified, one causing damage and mortality to potted lodgepole pine seedlings in the greenhouse at the Northern Forestry Centre, and the other causing needle chlorosis in white spruce seedlings at the Pine Ridge Forest Nursery at Smoky Lake. Damage to the lodgepole pine seedlings was caused by the black vine weevil *Otiorhynchus sulcatus* (F.) whose larvae feed on the roots. Damage to spruce foliage was caused by the mite *Nalepella halourga* Keif. This mite is a native species in Canada with a boreal distribution.

The Manitoba Department of Natural Resources submitted samples of conifer seedlings and soil to the Pacific Forestry Centre for identification of potential disease organisms. Specimens were from the Pineland Provincial Forest Nursery in Hadashville and the Clearwater Provincial

Forestry Nursery in The Pas. Colonies of *Pythium* and *Fusarium* were identified in most soil samples, but levels of infection did not appear to be high enough to cause concern for seedling mortality. Cultural treatment by tilling in the Pineland Nursery appeared to successfully reduce infection levels. Mortality of black spruce seedlings grown at the Clearwater Nursery had *Chaetomium* (saprophytic fungi) associated with them, but it was considered secondary to a stressed condition likely induced by environmental factors.

Pinewood nematode

Bursaphelenchus xylophilus (Steiner and Buhrer) Nickle

The pinewood nematode has gained worldwide attention in recent years because of its implications to the international trade in forestry products. Pinewood nematode is found only in low numbers and does not kill trees in Canada. But the consequences of its presence may be economically significant, affecting our ability to export forest products such as wood chips because of plant quarantine regulations in other countries.

The organism was first identified in North America in the late 1970s and was believed to have been imported from Japan, where it has been reported to have killed trees for at least 30 years. The pinewood nematode has been reported to be widely distributed in the United States and, in 1982, was reported in southern Manitoba. In 1985 the nematode was found in Ontario, and in 1986 in New Brunswick, Quebec, Manitoba, Saskatchewan, Alberta, and British Columbia.

Newfoundland

There have been surveys since 1985 to determine the distribution of pinewood nematodes in Newfoundland and Labrador and this effort continued in 1988 with emphasis on black spruce, white spruce, balsam fir, and larch in Labrador. All collections were processed and identified at the Memorial University of Newfoundland.

Possible vectors of this nematode were sampled in the summer of 1988 with insect traps placed near wood piles in several areas of the Province and near chip piles near the Grand Falls and Stephenville paper mills. Trap contents were sent to the university for nematode extraction and identification.

Maritime Provinces

Two surveys carried out are discussed below:

Tree surveys, 1985-1988: In the fall of 1985 and the summers of 1986 and 1987, a special survey was conducted in the Maritimes as part of a national effort to establish the presence and distribution of the pinewood nematode in Canada. Recently dead, old dead, and a few living trees were sampled and, from a number of locations, insects considered possible vectors for the nematode were also analysed. Samples were obtained from 207 locations (131 in New Brunswick, 55 in Nova Scotia, and 21 in Prince Edward Island). A further 21 locations were sampled in 1988.

Although the objective was to obtain a good species mix in sampling, balsam fir received special attention, especially in the early part of the survey, because of the similarity in symptom expression between Stillwell's syndrome and the supposedly sudden wilting of conifers killed by the pinewood nematode. No pinewood nematode has been identified from any of the balsam fir trees that succumbed to Stillwell's syndrome.

The "r" (round) form of *B. xylophilus* was identified at five of the 228 locations (2.2%) and from 7 of the 418 trees (1.7%) sampled. All "r" forms were from New Brunswick and they came from dead pine trees at Nevers Brook, Kent Co. (two locations); Jeanne Mance, Gloucester Co.; Mount Hebron, Kings Co.; and Pleasant Mountain, Albert Co.

The "m" (mucronated) form of *B. xylophilus* has been identified at 23 locations, 14 in New Brunswick and 9 in Nova Scotia. Two trees were infested at two locations; in the other areas, only individual trees were positive for the "m" form. Of the 25 infested trees, 18 were balsam fir and one each of black spruce, red spruce, Scots pine, eastern white pine, and jack pine. All but one of the trees from which the "m" form was extracted were recently dead, the exception being an old-dead eastern white pine tree from Nova Scotia. The highest number of "m" form nematodes extracted from infested trees was 18.

Vector survey, 1988: During the summer of 1988, a special pinewood nematode vector survey was conducted as part of a national effort. Special attention was paid to wood-inhabiting insects.

Sampling was done according to an established national protocol to ensure uniformity across Canada. Insects were collected in the forest, on slash or on log piles in cut-over areas, on logs, bark- and chip-piles in mill yards, and even "on freshly hung laundry in a backyard clothesline". Most insects were picked up while resting, others were trapped in bottles baited with attractants, and some, mainly bark beetles, were reared in the laboratory from infested logs. Although most of the sampling was done by Forest Insect and Disease Survey personnel, many samples were submitted by staff of provincial forestry services, mills, industrial companies, some municipalities, and some interested private individuals.

Although most samples consisted of single collections at particular locations, a special effort was expended on repeated collecting in the Nevers Brook, Kent County, N.B., area, where the "r" form of the pinewood nematode was found both in 1986 and 1987, even though in only a very few trees.

The pinewood nematode vector survey (260 collections) in the Maritimes in 1988 yielded 1676 specimens, representing 38 insect species belonging to six families (Cerambycidae, Buprestidae, Scolytidae, Curculionidae, Melandryidae, and Siricidae). Results of identifications will be available.

Québec

Surveys conducted in 1986 and 1987 revealed the presence of the pinewood nematode in Québec in its two main known forms. The "m" form was detected at roughly 20 sites, primarily on balsam fir, but also on a number of pines. The "r" form was detected in 1985 in a pile of Scots pine located close to La Pocatière. In most cases, the nematode was found on isolated or dying trees. It appears to be indigenous to our forests and does not cause significant damage.

In 1987 and 1988, our survey focused on the probable vectors of the pinewood nematode. Insects, particularly longhorn beetles, were collected on piles of recently cut logs along forest roads. Thirty-two sites, located primarily in the St. Lawrence plain, were sampled in 1987. No nematodes were extracted from these insects. In 1988, the sampling methodology was somewhat modified, particularly the aspects relating to the conservation and transportation of the insects and the extraction of the nematodes. Fifty-three sites were sampled, from Mont-Laurier in the west to the Matane Reserve in the east, and from the region of Saint-Félicien in Lac-Saint-Jean to the border with Maine, in the south.

Nine tree species were sampled: balsam fir (26 sites), jack pine (7 sites), white pine (6 sites), red pine (5 sites), eastern hemlock (2 sites), black spruce (3 sites), white spruce (2 sites), red spruce (1 site), and Norway spruce (1 site). A total of 1268 insects, primarily longhorn beetles and bark beetles, were sampled and then sent to Dr. J. Finney-Crawley at Memorial University in Newfoundland for extraction and identification of nematodes. Few insects sampled contained nematodes and none of them contained *Bursaphelenchus xylophilus*.

Ontario

Pinewood nematode surveys focused on several objectives in 1988. A program was begun to determine the rate of spread of the nematode at known infection sites, the type of form of the nematodes ("m" or "r"), and the possible role of various wood-inhabiting insects as vectors.

In each ranger work area, two pinewood nematode infection sites were selected and trees around these sites have been labeled as dead, symptomatic, or healthy. Thus it will be possible in future years to monitor any spread of the condition as it occurs at each site.

A number of samples were submitted to the survey unit from white and black spruce and balsam fir for nematode form determination. So far, all identified nematodes in these host species have been of the "m" form; however, the number of samples is too small to draw firm conclusions on whether only this form inhabits these three tree species.

Samples were shipped to Memorial University for vector and nematode identification. A total of 1454 samples of wood-boring and bark-inhabiting insects were submitted and results are expected in 1989.

Prairie Provinces

In Alberta, specimens taken from dying balsam fir were confirmed as pinewood nematode. The specimens were from trees in Sir Winston Churchill Provincial Park near Lac La Biche. No other reports were received in 1988. A total of 109 possible insect vectors were collected and sent for processing in 1988.

British Columbia

Based on more than 1000 samples from trees and potential vectors collected by Forestry Canada from throughout British Columbia since 1983, incidence of this nematode remains extremely low in forests. Only individual, predisposed trees are affected at a few widely distributed locations. Examinations of chip piles at 11 mills during optimum insect flight times and weather conditions in 1988 found only three possible vectors at two mills. Similar collections from slash piles and log decks resulted in 208 potential vector beetles being captured. Of these insects, 78 were three different species of *Monochamus*, 19 were *Buprestis* spp., 7 were *Pissodes* spp., 12 were *Cylindrocopterus* spp., 36 were *Hylurgops* spp., and 25 were *Dendroctonus* spp. Nematode extraction and identification are in progress.

North American Sugar Maple Decline Project

As a result of concerns about the future of maple stands and the production of maple syrup in eastern Canada and United States, Forestry Canada and the USDA Forestry Service created a joint study project on maple decline. Since 1988, 166 study plots have been established in four Canadian provinces and seven US states (Table 9).

Table 9. Number of study plots, by province or state, established under the North American Sugar Maple Decline Project.

Canada		United States	
New Brunswick	10	Maine	18
Nova Scotia	2	Massachusetts	10
Ontario	24	Michigan	10
Québec	24	New Hampshire	6
		New York	18
		Vermont	26
		Wisconsin	18
Total	60		106

The objectives of the project are:

1. to determine the rate of change in maple tree condition ratings from 1988 to 1990;
2. to determine if the rate of change in maple tree condition ratings are different between
   (a) various levels of acid rain, measured as wet deposition of sulphates and nitrates,

(b) sugarbush and undisturbed forest, and,
(c) various levels of initial stand decline condition, as established at the outset of the experiment ;

3. to determine the possible causes of decline and the geophysical relationship between the causes and the extent of decline, if applicable.

To achieve the project objectives, study plots were established in regions characterized by high and relatively weak levels of acid rain and by initial stand decline conditions estimated as high, moderate, or low. Half of the above sites were established in sugarbushes and the other half in undisturbed stands.

Five 20 x 20 m plots spaced at 20 m intervals were established on each study site. All trees were labelled, located, identified, their diameter and crown classes noted, and a brief evaluation of the condition of the trees provided.

A precise evaluation of the level of decline was conducted for each sugar maple. Four different parameters were measured:

1. the proportion of dead twigs and branches in the crown attributable to decline;
2. the relative leaf density in the crown determined by the amount of skylight visible through the foliated portion of the crown;
3. foliage discolouration;
4. the proportion of dwarfed foliage in the crown (leaves that are less than half the size of normal leaves on neighbouring trees).

Defects and wounds on the stem and the number and condition of tapholes, if any, were also noted. Finally, notes were taken on site conditions, including general soil type, slope, drainage, elevation, silvicultural practices, method of sap collection, and so on.

To date, 166 study plots have been established virtually throughout the range of maple in North America (Table 9). The location of the study plots in Canada is shown in Figure 8. Since the evaluation methodology is consistent for all sites and since each province or state involved was to establish sites in stands characterized by different levels of initial decline, we should obtain a relatively accurate idea of forest decline in the northeast. In addition, since most of the study plots were established in or near stations already being studied for decline, this project should permit a more valid comparison of the results obtained in a given study, relative to similar research conducted elsewhere.

The measurements taken in the summer of 1988 were computerized and are stored at New York State University's College of Environmental Science and Forestry in Syracuse. Preliminary compilations were performed.

The establishment and follow-up of the present project in Canada is the result of the excellent cooperation between the Forest Insect and Disease Survey of Forestry Canada and the forestry services of the provinces involved as full partners in this project. Forestry Canada is the project leader.

Acid Rain National Early Warning System

Acid rain has been a global concern for the past few years as effects of impurities in the air on lakes, buildings, and the forest are becoming more apparent. Acid rain means more than just rain with lower than normal pH falling from clouds that come from elsewhere. It includes any form of acid precipitation, both wet and dry, and air pollutants of different kinds from both near and far.

Concern over the future of Canadian forests has intensified as a result of the alarming tree mortality observed in other parts of the world. The Acid Rain National Early Warning System (ARNEWS) came into being in the early part of 1984 when the Canadian Forestry Service established a national program to detect early signs of acid rain damage to Canada's forests.

The objectives of the program are:

1. To detect possible damage to forest trees and soils caused by acid rain and to identify damage sustained by Canadian forests which are not attributable to natural causes or management practices;
2. Long-term monitoring of vegetation and soils to detect future changes attributable to acid deposition and other air pollutants in representative forest ecosystems.

The Forest Insect and Disease Survey was charged with the responsibility for (i) plot establishment, (ii) aboveground parameter monitoring and sampling, and (iii) providing assistance in obtaining foliage and soil samples for chemical analysis.

Newfoundland

In Newfoundland eight permanent plots have been established and are being monitored. Presently, there is no evidence of any noticeable effect of acid rain in the forests of Newfoundland. FIDS also established and maintained contact with other federal and provincial government agencies working on various aspects of acid rain.

Maritime Provinces

In the Maritimes Region, 15 permanent ARNEWS plots, representing the important forest species and geographical areas, were established in 1984. Two additional plots have been established in northwestern New Brunswick in 1985 at the request of and in cooperation with Fraser Inc. These will be monitored jointly with the Company in future years.

In 1988, all 17 plots were visited monthly from June to September to determine forest insect and disease conditions, detect 'acid rain' symptoms (if any), observe seed crop and premature fall discolouration, and collect ground vegetation samples. In August, detailed assessments of all plots were carried out following the procedures developed by the Maritimes FIDS Unit for the national system (Magasi 1988).

Foliage and soil samples are now available for analysis from all ARNEWS plots in the Maritimes. Information from increment cores collected in 1984 has been computerized in cooperation with the Petawawa National Forestry Institute.

Tree mortality, a topic often raised during acid rain-related discussions, is assessed annually on all ARNEWS plots. A summary of tree mortality at the ARNEWS plots in the Maritimes shows that an average of 1.6% of the trees on these plots died annually between 1984 and 1988. This figure includes mortality from all causes. For example, almost half (48%) of the 29 balsam fir trees that died during this period were on two plots in eastern Nova Scotia and another 34% on three plots in northwestern New Brunswick, both areas of severe spruce budworm outbreaks. None of the 93 maple trees died on any of the ARNEWS plots and all but one of the eight hardwood trees that died were white birch and were on the Martin Head plot in southeastern New Brunswick, where white birch is deteriorating (see 'Unexplained Situations'). The average annual hardwood mortality on ARNEWS plots in the Maritimes is 1.0% if these trees are included. Present data do not indicate any forest destruction in the Maritime Provinces from unexplained causes.

Needle Retention by Conifers

In addition to the work on permanent plots, the results of observations for signs of possible acid rain damage were recorded for most of the 346 locations where detailed pest condition assessments were made. Special attention was directed to the number of years of needle retention in coniferous species. It is apparent that the per cent of needles retained decreases with age of foliage, and the rate of the decrease varied among tree species and between provinces. Also, at least some of the loss is definitely attributable to feeding by defoliating insects. Similar information has been collected annually since 1985 in an effort to build a database that will allow analysis of possible changes.

Unexplained Situations

Forest Insect and Disease Survey personnel constantly look for unusual or unexplained forest conditions, some of which could conceivably be the result of acid rain damage. Unexplained forest conditions currently under observation are briefly described:

Condition of red spruce - In 1985, in the southern part of New Brunswick, red spruce was found to be deteriorating at many locations on Deer Island, Charlotte County. Although trees in many of these areas have been defoliated by the spruce budworm in the past, this does not adequately explain the condition observed. In 1986, permanent observation plots, each consisting of 50 trees, were established in Charlotte and Sunbury counties in New Brunswick and in Hants, Cumberland, and Halifax counties in Nova Scotia to follow changes in the condition of trees. The plot in Halifax County was cut in the summer of 1987.

Observations will continue in the other plots to establish possible trends in changes of condition.

Deterioration of white birch along the Bay of Fundy - Annual, early, and usually severe foliage browning and premature leaf fall along the Bay of Fundy have resulted in serious deterioration of white birch trees. The phenomenon was first reported in 1979 but the cause of the condition is not known. However, insects and diseases have been ruled out and some type of pollution is suspected as the causal agent. Multidisciplinary research was initiated in 1986 to investigate possible causes, including acid rain, acid fog, and ozone.

In 1988, foliage browning of white birch occurred again along the Bay of Fundy, both in New Brunswick and in Nova Scotia. The intensity of browning was variable from light to severe and the affected area was similar to that of previous years. Foliage discolouration occurred very much later than in past years but was unmistakably different from the normal autumn change in color usually observable around mid-September. The condition of the trees has been assessed annually on 11 permanent plots established in 1982.

Foliage browning, similar to that along the Bay of Fundy, occurred in some other areas in Nova Scotia. The most severe browning occurred in coastal areas in southern Cumberland, Colchester, and Halifax counties and in parts of Cape Breton and Richmond counties.

Condition of white spruce at Loch Katrine, Antigonish Co., Nova Scotia - Chlorotic foliage has been observed since 1985 on white spruce trees near Loch Katrine, Antigonish County, Nova Scotia in an uneven-aged stand of about 20 ha. The current foliage is green, but all older needles on affected trees exhibit various levels of yellowish discolouration. Not all trees in the stand are affected, but trees from all age classes show similar symptoms. Yellowing is more prominent on the upper surface of needles than on the underside. Needle retention of older foliage is less than that normally found on unaffected trees. Some of the trees have thin crowns. The cause of this condition is unknown but no insects or diseases appear to be involved.

In 1988, the condition was present again and additional white spruce trees in the general vicinity exhibited chlorotic foliage. Neither foliage nor soil samples, collected in 1987, showed major differences between affected and non-affected areas which might have explained the condition.

Québec

Twenty-five plots within the ARNEWS system were set up in Québec region; 13 in 1984 and 12 in 1985. All plot locations are officially registered and reserved as "experimental areas" with the Québec Department of Energy and Resources, Research and Development Division. The majority of these plots, with one exception, are located on provincial or institutional lands to provide good long-term protection. The one exception, containing the only white spruce stand we could locate and use, was destroyed through land development in 1987.

The remaining 24 plots were visited as planned during June 1988 to monitor the general stand condition. During August and September, for deciduous and conifer plots respectively, detailed evaluation and measurements were carried out. No definite acid rain symptoms or acid rain-induced changes were noted, although some forest rangers felt that some sugar maple plots appeared less healthy today than 3 or 4 years ago. Analysis of field data is planned for the coming year.

In the Québec Region, soil and foliage sampling and analysis were staggered over a five-year period (five plots/year) to reduce the time and expenses required annually to carry on the project. The first complete cycle of sampling and analyses will be completed during the 1989 field season.

Ontario

The Ontario FIDS Unit maintains 27 sample plots. They were designed to detect the early, rather subtle symptoms of acid rain damage as well as other biotic and abiotic factors affecting the health of forest trees. The plots are located across the province in various acid deposition zones and represent the major economic tree species in the province. Field data are still being analyzed but it may be said that no specific acid rain symptoms were observed in 1988, although a number of other agents were found affecting trees in some of the plots.

The forest tent caterpillar caused heavy defoliation on white birch, trembling aspen, and sugar maple in single plots in each of Sudbury and North Bay districts. Light damage by the same insect was reported in three plots in the Algonquin Region and one plot in the Central Region. Drought conditions caused discolouration of sugar maple foliage at one plot in the Sault Ste. Marie District of the Northeastern Region. The spruce budworm caused defoliation ranging from 10 to 70% on balsam fir, white spruce, and black spruce at three widely separated plots in the Northwestern and North Central regions. Light infections of western gall rust were reported on jack pine in single plots in each of Geraldton and Chapleau districts. Similarly, light infections of spruce needle rust occurred on black spruce in single plots in each of the Fort Frances, Dryden, and Geraldton districts, and low levels of tar spot needle cast were reported on jack pine in one plot in Chapleau District.

Prairie Provinces

Twelve permanent sampling plots were established, five in Alberta, three in Saskatchewan, and four in Manitoba. These are part of a nationwide network of permanent plots set up to detect and monitor changes in soil, minor vegetation, and tree growth. All ARNEWS plots were examined twice in 1988, once in June and again in late August or early September, and were monitored for insects, disease, and physiological damage. Basic plot data have been completed and forwarded to the Petawawa National Forestry Institute for computer input and summary.

British Columbia

Observations for acid rain symptoms, or symptoms that mimic those of acid rain, were made at 15 permanent

sample plots established across British Columbia since 1984. It is recognized that many factors, including a wide range of insects and diseases as well as climatic factors such as drought and regional air pollution, contribute to decline. While Forestry Canada continues to monitor forest health and continues to be concerned about potential acid rain and long-range transportation of air pollutants, no direct link or scientific proof of any damage caused by acid rain in western forests has been established.

More than 10 tree species and many species of ground cover were examined one or more times during 1988 in the 15 ARNEWS plots. Premature discolouration and loss of older needles of Douglas-fir and western hemlock at four sites were largely attributed to poor site conditions and drought conditions in 1985-87. A tip blight *Sirococcus strobilinus* Preuss in plots at the University of British Columbia Research Forest near Haney and in the Capilano Watershed moderately to severely infected 15% of the new hemlock shoots. Various needle or leaf fungi and defoliators were present at low levels, including *Septoria alni* Sacc., which caused moderate foliage discolouration on 20% of the red alder in one plot. Light mottling on birch leaves in the Coquitlam plot are symptomatic of ozone damage and some of the light chlorosis of older foliage on western hemlock are visually similar to air pollution effects such as the damage caused by sulphur dioxide. The plots will continue to be monitored closely, and chemical analysis of foliage will be completed and interpreted. Pollution experts will be shown both the material and the plots if the damage continues in 1989. Mixed-age spruce in a plot west of Castlegar were lightly mottled, and the causal agent was identified as abiotic. There was no evidence of change in the condition of trees and ground cover in plots near Terrace, Prince George, Penticton, and Campbell River.

New and older needles of about 60% of the mixed-aged class western hemlock were discoloured in patches within about 6 km of the pump mill at Port Alice on northern Vancouver Island; this was likely caused by sulphur dioxide. Over the long term this damage has resulted in dead tops on the hemlock in widely scattered patches over about 300 ha on the east side of Neroutsos Inlet. Foliage from hemlock in long-term study plots established by the British Columbia ministries of Environment and of Forests is being studied by Forestry Canada to determine if a chemical indicator of stress exists.

Pests in young stands and plantations

Newfoundland

In 1988 a preliminary survey throughout the Island determined the distribution of active infestation of the balsam woolly aphid *Adelges piceae* (Ratz.) in relation to the distribution of thinned stands. The total area of active balsam woolly aphid infestations covered about 160 000 ha on the Island and about 90% of damaged stands were thinned stands in western Newfoundland. Damage by the aphid is of serious concern to forest managers because effective controls on aphid populations do not exist.

Populations of the aphid are expected to increase. Research to develop effective, practical controls for this aphid will be conducted by the Newfoundland & Labrador Region in cooperation with Forestry Canada'sForest Pest Management Institute. More intensive surveys to delineate the distribution of aphid infestations and damage are planned.

High population levels of the black arm cutworm *Actebia fennica* (Tauscher) occurred in 1988 in burnt areas planted with black spruce, as well as in unplanted areas in western Newfoundland. Some planted areas in central Newfoundland were also infested. The Provincial Department of Forestry treated two infestations, one near Journois Brook and the other near Crabbes River, in western Newfoundland, and reduced cutworm numbers by 80% and 95%, respectively. Larval populations remained high in unsprayed areas in western and central Newfoundland and caused severe defoliation and seedling mortality. Pheromone traps were placed in all infested areas to monitor moth flights and to forecast next year's infestations.

Winter drying was common and moderate to severe, and damage occurred throughout most of Newfoundland in 1988. Young balsam fir growing in open exposed coastal areas on the Northern Peninsula from Sally's Cove to River of Ponds, and in the East Arm area in Gros Morne National Park were severely damaged. Severe damage in the St. Anthony area extended from Raleigh to Ship Cove and on the south side of Pistolet Bay from the junction of the St. Anthony Highway to Shallow Bay. Approximately 95% of the fir in exposed areas had dead tops and branches. A moderate incidence of winter drying occurred on Pinchgut Lake Road where up to 30% of the old foliage on balsam fir regeneration was affected. In Sitka spruce plantations near Chapel Arm and Come-by-Chance on the Avalon Peninsula trees were severely damaged by winter drying on exposed sites. Height growth was very poor in 1988 and multiple stems occurred on many of the trees from past damage. Moderate damage of winter drying was recorded on black spruce in St. John's. In Labrador about 30% of the young jack pine trees had up to 80% of the foliage affected in a stand along the Goose River Road.

Frost injured Sitka spruce trees severely, with 80% of the new foliage damaged in a plantation near Stag Lake in western Newfoundland. Moderate frost damage of balsam fir was recorded along the Burnt Berry Road near West Lake in central Newfoundland and along the Highlands River Road in western Newfoundland, where up to 10% of the foliage was affected on 30% of the trees.

Maritime Provinces

There were 268 plantations assessed by nine organizations, 188 in New Brunswick, 71 in Nova Scotia, and 9 in Prince Edward Island. The New Brunswick Department of Natural Resources also assessed 11 thinned areas. Observations were made on the type and level of forest pest-caused disturbances or damage. Field assessments were carried out by staff of the various organizations. Identification of samples and summarizing were done by FIDS. Analysis of data is in progress and details will be reported at a later date. Involvement in organized pest surveys of this type being a new undertaking, some companies viewed 1988 as a pilot year and limited the number of assessments accordingly.

There were 376 assessments made in the 279 areas surveyed; 35% of the plantations or thinned areas were visited twice during the season. A total of 18 800 trees were examined in the course of the surveys.

A few brief comments on some of the results follow.

1. In the Maritimes, over 90% of the almost 19 000 trees assessed were classified as healthy.
2. Tree condition in the thinned areas in New Brunswick was marginally worse than in plantations but no tree mortality was reported from any of the 11 areas.
3. Even though most trees were classified as healthy, there were at least some trees with severe damage in 39% of the plantations surveyed in New Brunswick, 45% in Nova Scotia, and 44% in Prince Edward Island.
4. There was no difference, on a regional basis, between pine and spruce plantations with regard to the occurrence of severely damaged trees, as 41% of the plantations of each species had at least some severely affected trees.

Spruce budmoths *Zeiraphira* spp.

Spruce budmoths on white spruce comprise a group of closely related species: the spruce budmoth, *Zeiraphera canadensis* Mutuura and Freeman, the purple-striped shootmoth, *Zeiraphera unfortunana* Powell, and the lesser yellow shootworm, *Zeiraphera fortunana* (Kft.). Generally, *Z. canadensis* is the most common and most important of the three but occasionally the species-mix changes in favor of one of the other two.

Spruce budmoth, a heretofore not-too-important forest insect in mature forests, became a major pest in 1980 when it was discovered to be causing defoliation, shoot distortion, and tree deformation in white spruce plantations over large areas in New Brunswick. In 1982, over two-thirds of the 180 locations surveyed in the Region were infested by spruce budmoth. At over 40% of these locations, in both New Brunswick and Prince Edward Island, defoliation and shoot

damage were in excess of 10%. Injury was classed as moderate or severe at 10 and 20%, respectively, in the locations surveyed. In 1988, spruce budmoths were widespread in white spruce plantations in the Region and considerable shoot damage occurred in some areas. In New Brunswick, an average of 10% of the shoots of white spruce trees were affected at locations scattered around the province. Although the average was the same as last year, considerable shoot damage occurred at some locations. The greatest amount of damage was recorded at St. Luc, Kent County, where 49% of the shoots were affected. Other areas with more than 20% shoot damage were at Guitar, Gloucester County (43%), Mt. Conacher, Restigouche County (31% by *Zeiraphera* sp.), South Portage, York County (24%), and Prince Settlement, Northumberland County (23%). Populations were lowest in some parts of Charlotte County.

In Nova Scotia, the insect was more common and the average shoot damage on white spruce increased to 12% from the 9% recorded last year. The most serious damage was observed at Mount Hanley, Annapolis County, where 71% of the shoots were affected; 63% shoot damage was recorded at Mount Denson, Hants County.

In Prince Edward Island, shoot damage occurred throughout the Province on open growing white spruce but an average of only 7% of the shoots were affected, compared to 15% observed last year. Local populations varied considerably, with the greatest amount of damage recorded at Auburn, Queens County, where 13% of the shoots were damaged and 80% of the trees were affected.

Control - In the fourth year of a developmental program towards control of the spruce budmoths, J.D. Irving Ltd., in cooperation with Forestry Canada - Maritimes, treated 9400 ha of white spruce plantations with a single application of fenitrothion (Sumithion®) in northwestern New Brunswick. The chemical was applied at 105 g/ha in a total mix of 0.42 L/ha per application (an UULV formulation). Treatment was timed to coincide with adult emergence and results confirmed findings of previous years that, when applied at suitable timing, enough adult moths are killed to impact on egg laying and significantly reduce damage the following year. Pheromones were used again in 1988 to time spraying operations, to monitor population levels, and for mating disruption experiments (second year of a 3-year study).

Seedling debarking weevil *Hylobius congener* D.T., Sch. & Marsh.

In 1988, the seedling debarking weevil continued to damage seedlings in newly planted sites, especially those which had been logged no longer than two years prior to reforestation. However, in recent years, forest managers in Nova Scotia and Prince Edward Island have taken steps to avoid losses (which have been as high as 90%). In Nova Scotia, sites have been evaluated for hazard from the weevil and dropped from planting plans for two or more years if the hazard rating was high. The principal criterion used to judge hazard has been a high content of conifers in the former cover type. In Prince Edward Island, control has been attempted by site preparation with anchor chains to disturb the litter and humus layers of the soil, thereby exposing mineral soil which deters the weevil.

An extensive survey was conducted throughout the Maritimes during the fall of 1988 to describe the damage and collect information to improve hazard forecasting in potential reforestation sites. In Nova Scotia and Prince Edward Island, the survey was conducted under contract with funding from their respective Federal-Provincial Forest Renewal Agreements. The survey in New Brunswick was conducted by the Forest Insect and Disease Survey. Information is not yet fully analyzed but the following preliminary observations provide the general situation. The three Maritime provinces contrast dramatically in damage caused by the weevil. At least some damage occurred in 30% of 60 plantations surveyed in New Brunswick, 100% of 70 plantations in Nova Scotia, and 61% of 51 plantations in Prince Edward Island. The percentage of sites where more than 5% seedling mortality was recorded was: 5% in New Brunswick, 49% in Nova Scotia, and 4% in Prince Edward Island. It is presumed that mortality would have been much higher in Nova Scotia had not a great many of the high-hazard sites been removed from reforestation plans. In Prince Edward Island a considerable number of seedlings may have been saved by the use of site preparation control tactics. A full analysis of data regarding the microsite in which each seedling was planted will likely provide an explanation.

Tests of various control options, including site preparation and physical barriers, continued during 1988 at five Nova Scotia sites. Research to develop a chemical control option continued at the Forest Pest Management Institute in cooperation with FIDS.

Armillaria root rot

The disease is widely distributed in the Region and mortality of both young and old trees was again common in 1988.

In New Brunswick, Armillaria root rot killed at least some trees in 16% of the 181 spruce and pine plantations surveyed. The 16% incidence of Armillaria infected plantations is lower than the 22% incidence found in 1987 but is the same as the level determined in 1986. Infection rates are generally low, mostly in the 2 to 8% range, but reach as high as 36% of trees dead or dying in an eight-year-old black spruce plantation at Hunters Brook, Madawaska County. Armillaria root rot also caused tree mortality in other forest situations. Mature and semimature balsam fir, black spruce, red spruce, and jack pine trees died in a number of areas in Victoria, Sunbury, Northumberland, Westmorland, and Kent counties. Mortality was as high as 24% in a mature balsam fir stand at Shaw Brook, Westmorland County. A few lodgepole pine trees were killed in a nursery in Carleton County, the disease was present in three black spruce seed orchards, and balsam fir Christmas trees died at Blacklands, Restigouche County.

In Nova Scotia, the disease killed at least some trees in 8.5% of the 59 spruce and pine plantations surveyed. The damage level was generally low, the highest incidence recorded was 5% tree mortality in a red spruce plantation north of Upper Mount Thom, Pictou County. Diseased trees were also found in two black spruce seed orchards. Tree mortality in natural stands occurred at scattered locations throughout the Province but mortality levels were usually

less than 3% in stands of red spruce, red pine, balsam fir, white pine, and larch.

In Prince Edward Island, Armillaria root rot was found in a black spruce plantation of approximately 10 ha, south of Hermonville, Kings County, where about 5% of the trees were affected.

Plots established in plantations to study the spread of the disease on different hosts and under different conditions have been assessed annually since 1983. The plantations are of different ages and were established in areas of somewhat different cover types. Only the three youngest plots were assessed in 1988 and some intensification was observed in two of the three plots. Trees in older plantations are said to acquire some resistance to fatal attack by Armillaria root rot, which they retain as long as they are in a vigorous condition without significant stress. Some of our study plantations are reaching this age. These plots will be observed annually but, unless conditions change significantly, they will be assessed only on a 5-year cycle. More plots of various species and especially of younger ages need to be established to assess the real significance of this disease in plantations.

Sirococcus shoot blight *Sirococcus congenus* (DC) P. Cannon & Minter

In 1988, the disease further intensified in all three provinces. In many areas repeated infection has resulted in serious deterioration of red pine stands and plantations; indeed, in some areas salvage operations were carried out.

In New Brunswick, Sirococcus shoot blight occurs mostly in the southern part of the Province, although affected plantations are known as far north as the line from southern Victoria to northern Kent counties. In 1988, the disease was found in a natural mixed stand at Crooked Depot, approximately 22 km southeast of Robinsonville, Restigouche County. Many semimature and mature red pine trees are affected in this stand, which is some 90 km farther north than previously reported infections. In the south, deterioration of trees in previously infected areas continued: 75% of mature and semimature trees died in a 2-ha plantation in the Mechanic Settlement area in Albert County; nearly all red pine trees were affected in a 50-ha plantation established in the early 1980s at McDougall Lake, Charlotte County where scattered, infected wolf trees were left; diseased trees were observed in several areas of Fundy National Park; there was tree deterioration in the Shin Creek area of Sunbury County; and, a new infection was found at Big Forks along the Salmon River in Kent County.

In Nova Scotia, infected red pine stands in Colchester, Cumberland, Hants, Queens, Shelburne, and Yarmouth counties continued to deteriorate, especially at Debert, Colchester County, at Diligent River and Chignecto Game Sanctuary in Cumberland County, in the Stanley Management Area, Hants County, and in the Kedge River Management Area, Queens County. Some plantations were salvage cut in 1987 and others, in the Rushy Lake area, Yarmouth County, were cut in 1988. Newly infected plantations were found in areas of Cumberland, Lunenburg, and Shelburne counties, and white spruce trees were infected in a clonal seed orchard in Colchester County. In eastern Nova Scotia, the disease reappeared in the Perch Lake Road area, Pictou County, where it was present in 1985 and 1986. The trees were cut in an effort to curb the spread of the disease but were not destroyed, thus an infection source likely remained. Newly infected trees were also found 4 km southwest of this area in a red pine plantation along the Cox Brook Road, and northwest of Lorne Station, Pictou County. Sirococcus-infected white spruce cones were found in the Province at 13 of the 17 locations where cones were collected for reforestation programs. An average of 22% of the cones were infected and incidence level ranged from 3% to 73% at the affected locations. The deterioration of pine stands by this disease in western Nova Scotia and the spread of the disease to plantations in the eastern half of the Province, where red pine has been a major plantation species in recent years, makes Sirococcus shoot blight one of the major plantation problems in Nova Scotia.

In Prince Edward Island, the disease was present at scattered locations including Goose River, Kings County, and Iona and Selkirk Road, Queens County where it has been under observation for some years. At Iona, where it was first reported on a few red pine trees in a 1-ha plantation in 1984, the number of infected shoots per tree has increased from "light" to about 60% on some of the fringe trees by 1986. Further intensification was noted in 1988. At Goose River, there was again a marked increase in shoot infection in a 3-ha, 23-year-old red pine plantation. First reported as light on a few trees in 1985, examination in 1986 showed that virtually all trees had some degree of damage, with about 5% of fringe and open growing trees supporting close to 50% shoot damage. There was no change at Selkirk Road, where the disease was observed for the first time in 1986, and about 1-2% of the red pine supported from 5- 29% damaged shoots on the lower crown branches. In addition to the above, diseased red pine trees were present near Murray River, Kings County; a few spruce shoots were found infected in a hedgerow in the Georgetown-Royalty area of Kings County.

Control - Prompted by concern over the fate of red pine plantations, silvicultural control (pruning) experiments were carried out in Nova Scotia during the fall of 1988 under the aegis of Forestry Canada. Results will not be available until at least 1989.

Quebec

The survey on the condition of trees in plantations was conducted from July 4 to September 2. Data were collected in 876 plantations: spruce-fir (424) and pine (452).

Spruce budworm *Choristoneura fumeferana* (Clem.)

Damage caused by the spruce budworm to spruce-fir plantations was not significant in the region. Only 8% of the spruce-fir outplanted in Quebec were damaged this year. The largest number of trees affected was in the Lower St. Lawrence - Gaspé Region, where 21% of the spruce-fir outplanted were affected. All trees affected were found in plantations affected at the trace level.

Spruce budmoth *Zeiraphera canadensis* Mut.& Free.

The spruce budmoth was observed in 87% of the white spruce plantations in the administrative region of Lower St. Lawrence - Gaspé, and 13% of the white spruce outplanted in this region had several leaders. In the administrative region of Quebec, 2% of the white spruce were affected.

Control - Experimental insecticide spray program to control the spruce budmoth was resumed in 1988 in plantations near the municipalities of Saint-Alexis, Saint-Jean-de-Matapédia, and Saint-François-d'Assise in the census division of Bonaventure. Test applications of diflubenzuron (insect growth regulator) and permethrin (synthetic pyrethroid) were sprayed on an area of 40 ha by helicopter. In plantations treated with permethrin, larval mortality was very high (80 to 90%), a large number of trees suffered no damage, few trees had broken or destroyed leaders, and the shoots were generally longer than those in untreated sectors. For a second consecutive year, diflubenzuron did not produce the anticipated results.

White pine weevil *Pissodes strobi* (Peck)

Damage by the white pine weevil was observed in 1% of the white spruce outplanted in Quebec. This percentage constitutes an insignificant increase over 1987 (0.4%). In 1988, this insect was found in 20% of the white spruce plantations whereas, in 1987, it was found in 16% of white spruce plantations. In Abitibi-Témiscamingue, this pest affected 10% of the white spruce trees. Damage was observed in 75% of these plantations. In the Outaouais, damage was observed in one of every two white spruce plantations, but only 1% of the white spruce trees in this region were damaged by the white pine weevil. In the regions of the Lower St. Lawrence - Gaspé, Saguenay - Lac-Saint-Jean and the North Shore, the white pine weevil was virtually nonexistent in white spruce plantations.

The white pine weevil is more active in Norway spruce, affecting one plantation out of three. In 1988, damage was observed on 2.8% of Norway spruce trees in Quebec, compared to 3% in 1987. The main regions in which damage was observed were Trois-Rivières, the Eastern Townships, the Outaouais, and Montreal, where 68%, 83%, 80%, and 42%, respectively, of the Norway spruce plantations were affected. In these regions, damage attributable to the white pine weevil were observed on roughly 6% of the Norway spruce. In the Quebec Region, damage was observed on more than 3% of the Norway spruce in nearly 40% of the Norway spruce plantations. The insect was reported for the first time on Norway spruce in the Saguenay - Lac-Saint-Jean Region, and on several occasions in the Lower St. Lawrence - Gaspé. It has not been reported in the administrative regions of Abitibi-Témiscamingue or the North Shore.

Damage by the white pine weevil was observed on 9% of the white pine trees in the Montreal Region. The trees affected were located in plantations where recent activity of this insect was evaluated to be light. In the Outaouais Region, only 0.3% of the white pine were damaged by the white pine weevil and they were located in plantations where recent activity of the insect was at a trace level.

Other Insects

The redheaded pine sawfly *Neodiprion lecontei* (Fitch) was found in 4% of the red pine plantations in Quebec, affecting 0.3% of the trees. The population of this insect increased significantly in the Montreal Region, affecting 2.7% of the red pines, whereas in 1987 it affected only 1%. It was observed in 12% of the plantations, compared to 21% in 1987. In the Outaouais Region, less than 0.1% of the red pines were affected. The sawfly was found in only 7% of the plantations in this Region, whereas in 1987 it affected 28%. In all cases, the level of defoliation forecast for 1989 seldom exceeds the trace level.

The pine nodule maker *Petrova albicapitana* (Busck) was frequently reported in jack pine plantations in the administrative regions of Saguenay - Lac-Saint-Jean and Trois-Rivières, where it affected 4% and 5% of the trees, respectively. This insect is found in three out of every four jack pine plantations in Saguenay - Lac-Saint-Jean and in two out of every three plantations in the Trois-Rivières Region.

The European spruce sawfly *Gilpinia hercyniae* (Hartig) was present throughout Quebec, primarily in the Lower St. Lawrence - Gaspé, where it was observed in more than 38% of the spruce-fir plantations. However, it caused very little defoliation.

The pine needle miner *Exoteleia pinifoliella* (Chambers) affected a number of plantations in the southern part of the administrative region of Trois-Rivières. This insect generally causes only sporadic and isolated damage. However, of the 19 jack pine plantations visited in this area, eight had damage on close to 100% of the trees.

Disease - This year, scleroderris canker was found on 3% of the pine trees in Quebec, affecting one out of five plantations in the province. In the Lower St. Lawrence - Gaspé Region, 19% of the pines suffered from scleroderris canker, which was found in one of every three plantations. On the North Shore, scleroderris canker was found on 32% of the jack pine trees, and in the administrative regions of Quebec, Trois-Rivières, and Montreal, the disease was found on 5%, 14%, and 4% of the red pine trees, respectively. Scleroderris canker was virtually non-existent in the Eastern Townships and Abitibi-Témiscamingue. (A control program has been implemented in the Eastern Townships for the past two years).

White pine blister rust *Cronartium ribicola* J.C. Fischer was found on 3% of the white pine outplanted in the province, compared to 2% in 1987. The regions of Trois-Rivières and Quebec City were the main regions affected, with 10% and 9%, respectively, of the white pine being affected this year, compared to 9% and 4% in 1987. There was, therefore, a significant increase of this disease in the Quebec City area.

Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka was found in 23% of all jack pine plantations. This pathogen occurred in 50% and 80% of the jack pine plantations in the Saguenay - Lac-Saint-Jean and the North Shore, respectively. However, few trees were damaged by this disease. In fact, only 1% and 3% of the

jack pine trees outplanted in Saguenay - Lac-Saint-Jean and the North Shore, respectively, were affected.

Climatic damage - Like last year 5% of the spruce-fir plantations in Quebec had late frost injury. In the Saguenay - Lac-Saint-Jean and Montreal regions, 11% and 18% of the spruce-fir plantations suffered from the effects of this abiotic factor.

Christmas Trees - Close to 1 000 000 balsam firs at 26 plantations and 35 000 Scots pines at five plantations were inspected. It is estimated that there were more than 880 000 Christmas trees in the 21 plantations visited in the Eastern Townships. The main problems observed are late frost injury, needle rust, and balsam twig aphids. Damage was very localized and varied from trace to light levels.

Ontario

Conifer plantation surveys have been carried out for a number of years as part of a long term project to determine the effect of various pests upon coniferous plantations in the province. In 1988 these surveys focused on jack pine plantations in northern Ontario and red pine plantations in southern Ontario. Two visits are made to each plantation in order to accommodate the feeding period of a variety of pests known to attack various coniferous species. In the jack pine survey in northern Ontario a total of 9 850 trees were examined, and 4 500 trees were examined in the southern Ontario red pine survey.

Red Pine

Insects - The most prevalent insect in the red pine survey was the pine false webworm *Acantholyda erythrocephala* (L.) which was found on 305 trees, approximately 7% of the total. Defoliation of affected trees averaged 15.3% and the most severely affected plantations were in the Carleton Place, Minden, Bancroft, and Pembroke districts. The European pine needle midge, *Contarinia baeri* (Prell) was found on 138 trees, 3% of the total, most of which were located in the Bancroft and Carleton Place districts. Defoliation in most cases was less than 1%. The European pine shoot moth *Rhyacionia buoliana* (D. & S.) was found infesting 129 trees, although most of the damage occurred on lateral branches with only three leaders affected. Other potentially damaging insects found in low numbers included the European pine sawfly *Neodiprion sertifer* (Geoff.) (14 trees), the redheaded pine sawfly *Neodiprion lecontei* (Fitch) (32 trees), and the Saratoga spittlebug *Aphrophora saratogensis* (Fitch) (3 trees).

Diseases - The most widely encountered disease was the pine needle rust *Coleosporium asterum* (Dietel) Sydow. It was found on 347 or 5.5% of the trees at widely scattered locations in the Eastern, Algonquin, and Central regions. Defoliation ranged from 1 to 10.7% and averaged 3.9%. Brown spot needle blight *Lecanosticta acicola* (Thüm.) H. Sydow was found on 48 trees affecting 6.2% of the foliage in one plantation in Wicklow Township, Bancroft District. A needle cast fungus *Lophodermium* sp. occurred on 12 trees causing <1% defoliation, and Armillaria root rot was found on seven trees. Some 56 recently dead trees were counted, most of which were small trees that had succumbed to drought.

Jack Pine

Insects - The most abundant insect was the jack pine budworm *Choristoneura p. pinus* Free. , which was found on 719 trees or 7.3% of the total. Defoliation by this insect averaged 2.2% of affected trees. Most of the affected trees were in the Sioux Lookout, Ignace, and Red Lake districts. The eastern pine shoot borer *Eucosma gloriola* Heinr. destroyed the leaders on 169 trees and was found infesting lateral shoots on 276 trees. The bulk of the damage by this insect occurred in the Espanola, Sudbury, and Thunder Bay districts. The white pine weevil *Pissodes strobi* (Peck) infested 181 trees or 1.8% of the total, the largest number of which were in the Espanola, Sudbury, and Chapleau districts. The jack pine tip beetle *Conophthorus banksianae* McP. was found on 160 trees, of which 118 had the leaders destroyed. The northern pitch twig moth *Petrova albicapitana* (Busck) was recorded on 39 trees.

Diseases - The most commonly encountered disease was pine needle rust *Colesporium asterum* (Dietel) Sydow which infected 1 446 trees or 14.7% of the total. Although the incidence of the disease was as high as 100% in some plantations, the average foliage damage on infected trees was only 4.9%. The second most abundant disease was eastern gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hirats. which occurred on 1 141 trees or 11.6% of the total. While the disease was widely distributed throughout northern Ontario, the most severe infections were located in the Northwestern and North Central regions. Tar spot needle cast *Davisomycella ampla* (J. Davis) Darker was found on 586 trees or 5.9%, causing average foliar damage of 12.7%. Stem rusts, *Cronartium* spp., were found on 52 trees and Armillaria root rot was found on 32 trees. Sixty five of the 9 850 trees examined were dead, with a significant proportion of the mortality caused by eastern gall rust and Armillaria root rot.

Prairie Provinces

A committee with representatives from the three prairie provinces and Forestry Canada was established in 1987 to develop a standardized field survey method suitable for conducting pest surveys in high-value conifer stands within the region. The method seeks to provide a means to systematically sample and quantitatively assess plantations and naturally regenerated areas for incidence of damage agents, tree mortality, stem deformities, and other damage effects. The method was revised for the 1988 field season and applied uniformly throughout the region, except in Manitoba where plantations were sampled more intensely.

A total of 124 plantations and other high-value conifer stands, 4- to 25-years-old, were surveyed in 1988 at various locations. Across the region, top kill was highly variable and was most severe on white spruce. Animal browse, frost injury, spruce bud midge, and white pine weevil were the important damage agents on this species. Stem deformity, expressed as leaning or severe crookedness of stem, forked

top, or top branchiness, generally ranged between 6 and 10%, while tree mortality was usually less than 5%. Armillaria root rot, western gall rust and other pine stem rusts, and the Warren's rootcollar weevil were the most important mortality factors of lodgepole pine and jack pine.

British Columbia

Surveys of young 2- to 25-year-old, natural and planted conifer stands across the province continued to identify major pests and their impact. More than 11 770 trees in 914 plots in 129 stands were examined in 1988. Pest problems included black army cutworm, Rhizina root disease, pine and spruce terminal weevils, pine root collar weevil, western gall rust, animal damage, pine stem rusts, and adelgids on Douglas-fir and spruce. The overall incidence of damage by the pests was variable and often severe in localized areas. Tree mortality was usually less than 10%.

Black army cutworm

Conifer seedlings and herbaceous ground cover were severely defoliated and some planting programs delayed by increased black army cutworm populations in 2-year-old burns in the Cariboo, Nelson, Prince George, and Prince Rupert regions.

Conifer seedlings and herbaceous ground cover were defoliated in several recently planted sites in the Nelson Forest Region including the Giby fire, but not in the Ram fire east of Canal Flats where high populations and severe defoliation occurred in 1987. Elsewhere in the East Kootenay, 88% of the Engelmann spruce and Douglas-fir seedlings near Bush Harbour were totally stripped by this cutworm. Near Donald, aspen and willow regeneration was defoliated, but damage to lodgepole pine seedlings was minimal and high numbers of larvae were observed east of Golden. East of Mica Dam in the West Kootenay, 45% of the Engelmann spruce planted in 1987 in a 107-ha burn and a nearby 1986 burn were stripped. This is the first cutworm infestation recorded in this area. All ground cover over half the area was consumed and pockets of complete defoliation were scattered throughout the remainder.

Increased populations in 1986 burns in the Prince George Region defoliated seedlings and ground cover. Near McBride, white spruce and Douglas-fir seedlings and all the ground cover over 30 ha were severely defoliated. North of Prince George, white spruce planted this year were not affected by increased numbers of cutworm but ground cover was lightly to moderately defoliated.

In the Prince Rupert Region, cutworm were more numerous than in 1987, particularly in the west; however, damage was restricted mostly to herbaceous ground cover. Of 31 sites surveyed in the eastern part of the region, seedlings were only lightly damaged over about 1 ha and herbaceous ground cover, mainly fireweed, was defoliated at three others. Larvae at three burns in the western part of the region in the Bell-Irving River drainage lightly defoliated abundant fireweed but seedlings were not damaged.

In the Cariboo Region, 60 to 100% of the Douglas-fir seedlings and most herbaceous ground cover in three 1986 burns west of Likely were severely defoliated.

Cutworm larvae were present in the Clearwater Forest District, Kamloops Region but only in very low numbers. Very light feeding damage to herbaceous ground cover was recorded in one of eight sites burned in 1986, but spruce and pine seedlings were not damaged.

Variable levels of parasitism by Hymenoptera and Diptera were found in 11 mass-reared collections of black army cutworm larvae and pupae from the Nelson, Prince Rupert, and Prince George regions. In two new infestations near Golden, parasitism of cutworm larvae ranged from 11 to 19%. As well, the entomopathogen *Beauveria bassiana* (Bals.) Vuill. killed 42% of the larvae reared from one location. In a single collection from the Giby fire in the Nelson Region, larval parasitism increased to 37% in 1988 from 2.3% in 1987. At six sites in the Prince Rupert Region, larval and pupal parasitism, respectively, averaged 33% (range, 3 to 67%) and 22%. Larval parasitism at two sites in the Prince George Region averaged 44%.

Populations are forecast to continue near most currently infested areas. This is based on 372 sticky traps, baited with experimental pheromones, that attracted up to 97 male moths per trap at 51 of 70 sites in four regions. Additionally, 23 of 80 traps at 9 of 16 sites in the Clearwater District in the Kamloops Forest Region attracted 37 male adults, but even the highest number per trap (5) near Blue River indicates low populations. Cutworms could pose a threat in 1989 to plantations in the interior of British Columbia in areas that were slash-burned in 1987.

A contract to develop a predictive warning system linking moth catches in non-sticky pheromone traps with subsequent defoliation and seedling and vegetation damage completed its second field year and results are being analyzed. This study is building on earlier studies by Dr. R. Shepherd at Forestry Canada, Victoria in cooperation with FIDS.

Rhizina root disease (*Rhizina undulata* Fr.)

Seedling mortality linked to infection by Rhizina root disease *Rhizina undulata* Fr. was found in 18 of 87 recently planted sites burned in 1987 in wetter parts of the Prince Rupert, Nelson, and Prince George forest regions. This was the first significant seedling mortality from this pathogen, recorded by FIDS since 1969. Fruiting bodies were present in six additional areas but there was no evidence of seedling mortality.

In the Prince Rupert Region, an average of 14% (range 3 to 34%) of the white spruce, Sitka spruce, and lodgepole pine seedlings were killed or dying in 10 plantations. The greatest mortality was recorded northeast of Meziadin Lake where 17% of the lodgepole pine seedlings were killed and 17% were chlorotic and stunted adjacent to fruiting bodies.

In the Nelson Region, an average of 9% (range 2 to 26%) of the Engelmann spruce, lodgepole pine, and Douglas-fir seedlings were killed in eight plantations west of Kimberley to near Golden and from Slocan to Revelstoke. The highest (26%) occurred in a plantation in the Bush River Valley northeast of Golden.

The root disease was collected for the first time in the Prince George Region near Weedon Lake north of Prince George where 1% of the planted lodgepole pine seedlings

were killed, but no seedlings were killed at Frank Lake where fruiting bodies were common.

Mass fruitings of Rhizina in forest situations may follow wild fires or prescribed burns. Because it is a poor competitor, the fungus normally survives for only a few years after the burn, after which it is succeeded by more aggressive soil fungi. Most seedling mortality occurs within the first year of infection but mortality of Douglas-fir on the same coastal sites was reported for two successive years in 1968/69.

Animal damage

Feeding damage to recently planted conifer seedlings by high numbers of voles, *Microtus* spp., increased significantly in the western part of the Prince Rupert Region and killed seedlings on southern Vancouver Island. Damage was not evident, however, in the eastern part of the Prince Rupert Region where seedling mortality was prevalent in 1987.

Feeding damage occurred on an average of 10% (2-56%) of the recently planted lodgepole pine and Sitka spruce at 13 sites from Kitimat to the Bell-Irving River Valley, but seedling mortality was less than 5%. Voles killed about 50 western hemlock and western red cedar seedlings at a research site west of Mesachie Lake on southern Vancouver Island. Terminal clipping caused by hares, *Lepus* sp., occurred sporadically in the western part of the Prince Rupert Region on 8% and 25% of the pine seedlings at two of four sites on the Kalum Road and 21% of the Sitka spruce in a plantation at Lakelse. Although minor clipping of lower branches at three plantations affected 92% of the spruce at one plantation in the Kitimat River Valley, 67% at Nalbeelah Creek, and 20% at Kalum Lake, damage was very light and patchy and little mortality is expected. Mortality of young and semimature conifers killed by porcupine chewing of patches of bark on stems and branches continues to be common in the western part of the Prince Rupert Region.

Half the recently spaced immature lodgepole pine in pockets of 1 to 2 ha throughout a 50-ha site on the Palmer Lake Road in the Cariboo Region were completely girdled at the base by rodents, seriously affecting stocking. Numerous whitebark pine in the Heckman Pass area west of Anahim Lake were killed by girdling about 1 m above ground level. Rodent feeding was common also on lodgepole pine infected by blister rust south of Hanceville.

Other pests in young stands and plantations

Across British Columbia, new attacks by the pine terminal weevil *Pissodes terminalis* Hopping averaged less than 5% in 16 of 59 lodgepole pine stands. Infections by western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hirat. occurred mostly on branches and were highest (24% of the trees) in four stands in the Okanagan and less than 10% in 15 infected stands in five regions.

Spruce leader mortality by attacks of white pine weevil *Pissodes strobi* (Peck) varied. On Vancouver Island, 50% of the terminals in one of seven plantations were killed; 5 to 10% of the terminals were killed at the other six plantations. Current attack near Bella Coola averaged 28% on 2- to 10-m Sitka spruce. Additionally, more than 50% of the terminals were killed in five areas over more than 3000 ha on the west coast of Vancouver Island surveyed by the British Columbia Forest Service. In the western part of the Prince Rupert Region, weevil attacks averaged 24% (range 5 to 44%) in 10- to 15-year-old Sitka spruce at 22 sites. New attacks on Engelmann spruce at six sites in the Nelson Region averaged 11% (range 3 to 35%).

Increased populations of pine root collar weevil *Hylobius warreni* Wood infested immature lodgepole pine in 15 of 59 planted and naturally regenerated sites in six forest regions and killed up to 15% of the trees. Near Hazelton in Prince Rupert Region, an average of 76% of the 4- to 20-year-old lodgepole pine in five stands were infested but, to date, only about 5% have been killed.

Stem infections on suppressed naturally regenerated lodgepole pine by Comandra blister rust *Cronartium comandrae* Pk. were prevalent in the eastern part of the Prince Rupert Region. Rodent feeding around the edges of the infections was common. In the Cariboo Region, stem cankers of stalactiform blister rust *C. coleosporioides* Arth. were up to 3 m long on about half of the intermediate lodgepole pine over 10 ha south of Hanceville. About 2% of the pine were killed by infection and rodent girdling of the cankers, which were also common on living trees, and by attacks by the pine engraver beetle *Ips pini* (Say).

Cooley spruce gall adelgid *Adelges cooleyi* (Gill.) frequently infested and discoloured more than 50% of the new tips of interior white and Engelmann spruce and Douglas-fir; however, immediate and long-term impact of the damage is considered minimal.

Less common pests in young stands included Armillaria root disease which infected small numbers of trees in parts of the Nelson and Kamloops regions. The conifer-aspen rust, *Melampsora medusae* Thuem., was common in young stands in the Prince George Region; larch needle disease, *Meria laricis* Vuill., was also common in the Nelson Region.

Other insects and diseases

Newfoundland

Armillaria root rot
Armillaria spp.

In 1988 root washings were carried out to detect *Armillaria* in the former black spruce decline plots first established in 1983 near Northwest Gander River on the Bay d'Espoir Highway. These black spruce stands had been damaged by the spruce budworm prior to 1983. Armillaria root rot affected about 25% of the surviving black spruce trees in 1988 that had been classed as lightly or moderately damaged in 1983. Nearly 70% of the surviving trees in the 'severe' category had root rot. *Hylobius* was recorded on 45% of all trees examined and frequency of damage was not related to damage category.

The root rot was also recorded on many Sitka spruce planting sites throughout the province, with up to 5% of the trees dead or dying. The disease was recorded in planted red pine in Northern Arm near Botwood and on young jack pine in a stand on the Goose River road in Labrador.

Blackheaded budworm
Acleris variana (Fern.)

An infestation of the blackheaded budworm *Acleris variana* (Fern.) was recorded on the Northern Peninsula along the Roddickton Road. Moderate and severe defoliation occurred on about 3700 ha and light defoliation on about 4300 ha. Population levels ranged from about 40-500 larvae per beating sample. The budworm caused 50-100% defoliation of current foliage in overmature stands of balsam fir.

Past outbreaks of this budworm usually subsided in 2-3 years without causing tree mortality. However, in 1988 small patches of overmature white and black spruce trees throughout the infested area were killed.

Eastern Dwarf Mistletoe
Arceuthobium pusillum Peck.

Dwarf mistletoe continued to spread in a black spruce stand near Gambo. The wet site favours spread of the disease, and in six years the infection has spread to 23% of the spruce trees.

Ontario

Bruce spanworm
Operophtera bruceata (Hist.)

The total area of moderate to severe defoliation declined from 1 053 717 ha in 1987 to 682 295 ha in 1988. Major infestations which occurred in the Northeastern and Algonquin regions in 1987 collapsed in 1988 with only a remnant 1 840 ha of defoliation in the Tunnel Lake area of the Blind River District, Northeastern Region. The remainder of the defoliation was located in the southern Thunder Bay District and the southwestern corner of Atikokan District of the North Central Region. The major part of this (55 860 ha) occurred in a single large infestation stretching from the Basswood Lake-Chatterton Lake area of Atikokan District east across the southern Thunder Bay District to Lake Superior. Other sizable infestations were located in the Gorham Township-Dorion-Sibley Peninsula area of the eastern Thunder Bay District (94 488 ha) and in the Trotter and Weaver townships area on the Thunder Bay-Atikokan District boundary (14 470 ha). A number of smaller pockets were located around the periphery of the large infestation described above. Trembling aspen was the main host for the insect in the North Central Region while sugar maple was the main tree species attacked in the Blind River District of the Northeastern Region.

Abiotic factors

Drought - Prolonged lack of rain, combined with higher than normal temperatures, caused widespread drought damage to Ontario forests in 1988. Altogether, some 203 064 ha of moderate to severe damage were mapped by aerial and ground surveys. Most of the damage occurred in the central part of the province in the Algonquin Region (14 252 ha) and the Northeastern Region (37 318 ha). Extensive damage to forest trees was also recorded over 20 176 ha in the Eastern Region and 3 035 ha in the Central Region. The most severe damage occurred on exposed areas such as hilltops, ridges, and other areas where trees were stressed by dry, shallow, or rocky soils. Although most species were affected to some degree red oak, sugar maple, and red maple appeared to be the most severely damaged followed by yellow birch, white birch, and white pine. A wide range of damage was evident including outright mortality of trees, twig and branch mortality of varying degrees, and premature leaf drop with an apparently healthy set of new buds. It is expected that the effects of this drought, in the form of dying trees, growth reduction, and crown deterioration will be evident for several years.

Blowdown - Heavy windstorms in 1988 severely damaged timber over some 35 162 ha in Ontario. Most of the damage (32 811 ha) occurred in the North Central and Northwestern regions. This was the result of severe storms in late June which left a trail of broken off and uprooted trees through the northern Dryden District, the southern Sioux Lookout District, northern Ignace District, and the northeast corner of Thunder Bay District. Extensive damage was also evident in the southern Fort Frances District. In addition, severe storms in early August damaged timber over 2 351 ha in the Bancroft, Pembroke, Bracebridge, and Minden districts of the Algonquin Region. A survey of the downed timber in the Northwestern and North Central regions indicates that most of the trees were blown over and most stems were off the ground with little root contact remaining. A number of the trees had snapped in two and occasional trees remained standing. The main species affected were black spruce, trembling aspen, jack pine, and balsam fir along with lesser amounts of white spruce and white birch.

Prairie Provinces

Dwarf mistletoe
Arceuthobium americanum Nutt. ex Engelm.

In Alberta, dwarf mistletoe on lodgepole pine was observed causing considerable mortality in Jasper National Park in the vicinity of Jasper townsite and south of the townsite along Highway 93 to the Sunwapta Falls area.

In Saskatchewan, dwarf mistletoe is a widespread parasite of jack pine stands throughout the Mixedwoods Forest Section. The Saskatchewan Department of Parks, Recreation, and Culture has salvaged unproductive dwarf mistletoe-infested jack pine stands in the Nisbet Provincial Forest for use as firewood. These areas have been scarified and regenerated.

In Manitoba, dwarf mistletoe is generally considered the most damaging pest of jack pine and an intensive management program for this disease has been implemented over the last 5 years. The program has included surveys, research, and sanitation treatment. A comprehensive aerial survey was conducted over approximately 7000 km of jack pine forest within the following Forest Management Units: FMU 23 in the Pineland Forest Section; FMUs 45, 46, and 47 in the Interlake Forest Section; and FMUs 51, 53, 55, 56, and 57 in the Saskatchewan River Forest Section. Contracts were drawn up with the University of Manitoba Botany Department to investigate the biology of *A. americanum* on jack pine and to develop a loss simulator model. Sanitation projects included post-logging treatments and thinning and pruning in juvenile stands.

British Columbia

Douglas-fir tussock moth
Orgyia pseudotsugata (McDunnough)

For the first time since the last outbreak collapsed in 1985, tussock moth larvae, pupae, and egg masses were reported on Douglas-fir trees in urban Kamloops. Relatively few egg masses were collected at 13 sites in the Kamloops Lake area, at one site near Hedley in the southern Okanagan, and on two newly defoliated ornamental spruce in Victoria. An infestation is not expected in 1989.

Pheromone-baited sticky traps continued to be placed in 17 Douglas-fir stands selected for the greatest historical frequency of outbreaks in the Kamloops Region. The number of male adults trapped increased for the third consecutive year to 1239 adult males in 58 of 100 traps at 13 of 17 sites. This is up from 387 adults in 45 traps and 75 adults in 25 traps in 1987 and 1986, respectively. An additional 478 adult males were trapped in 25 of 33 extra traps at 33 locations near sites with increases in 1987. Numbers decreased in the Nelson Region, with only one adult per trap at one of two locations; in 1987, four and seven adults per trap were caught at the same two locations.

Increasing trends over two or three years or an average catch of 25 or more male moths per trap indicate potential visible defoliation within two summers. Trap catches reached this level near Kamloops and in the Okanagan Valley in stands near Winfield, Vernon, and between Savona and Pritchard. Egg-mass surveys in these areas indicate slowly increasing populations and the potential for defoliation in 1990. An average of three egg masses were found at 13 sites surveyed over about 1000 ha in the Kamloops Lake area and near Hedley. All but two masses were found on single trees during the survey which took approximately 100 hours. The highest number per site was south of Kamloops Lake where 10 and 4 egg masses were found at two sites, and on the Dominic Lake Road where nine new egg masses were found at one site. None was found at nine additional sites in the Kamloops area or at seven sites in the Okanagan-Similkameen area.

Western hemlock looper
Lambdina fiscellaria lugubrosa (Hulst.)

Infestations at Jervis Inlet in the Vancouver Region that severely defoliated western hemlock, cedar, maple, and other deciduous understorey trees and shrubs over about 90 ha in 1987 collapsed in 1988. The collapse is probably due to egg parasitism, as larvae were not present in the stand in 1988. About 75 western hemlock and 25 immature and mature western red cedar were killed as a result of defoliation. Most of the western hemlock were predisposed by infection by hemlock dwarf mistletoe *Arceuthobium tsugense* (Rosendahl) G.N. Jones.

Other Insects, Disease, and Damage

Newfoundland and Labrador Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
Alder leafminer *Fenusa dohrnii* Tischb.	Speckled alder	Central Newfoundland	Low populations and light defoliation.
Anthracnose *Kabatiella apocrypta* (Ell. & Ev.) Arx	Red maple	Western Newfoundland	Low incidence. 5% of the foliage affected on a few trees.
Balsam fir sawfly *Neodiprion abietis* complex	Balsam fir	Western Newfoundland Eastern Newfoundland	Low populations and no significant defoliation.
Balsam twig aphid *Mindarus abietinus* Koch	Balsam fir	Newfoundland	Low to high numbers. Light damage.
Birch leafminer *Fenusa pusilla* (Lep.)	White birch	Western and central Newfoundland	Low to high populations.
Black knot *Apiosporina morbosa* (Schw.) Arx	Pin cherry Domestic cherry Damson plum	Newfoundland	Common and widespread.
Blister rust *Cronartium ribicola* J.C. Fischer	Bristly gooseberry	Eastern Newfoundland Avalon Peninsula	High incidence on alternate host (*Ribes* spp.) on Avalon Peninsula.
Broom rust *Melampsorella caryophyllacearum* Schroet.	Balsam fir	Northern Peninsula Eastern Labrador	Scattered throughout eastern Labrador with 1 to 2 brooms. Up to 30% of the trees in some localities.
Cone rust Chrysomyxa *pirolata* Wint.	Black spruce White spruce	Eastern Newfoundland Avalon Peninsula	Less than 1% of the cones affected on approximately 15% of black spruce examined.
Eastern blackheaded budworm *Acleris variana* (Fern.)	Balsam fir Black spruce White spruce	Newfoundland Eastern Labrador	High populations caused light to severe defoliation in a large infestation in western Newfoundland.
European poplar canker *Dothichiza populea* Sacc. & Briard	Lombardy poplar	Avalon Peninsula	Mortality and dieback occurred on young and old poplars.
European spruce sawfly *Gilpinia hercyniae* (Htg.)	White spruce Black spruce	Western and central Newfoundland	Low to moderate populations. Trace of current defoliation in precommercial thinned area in central Newfoundland.
Fall webworm *Hyphantria cunea* (Drury)	Speckled alder	Western Newfoundland	Nests were common again this year throughout the Black Duck - Stephenville area.
Gray mould blight *Botrytis cinerea* Pers.	Lodgepole pine Japanese larch	Western Newfoundland	Up to 10% of seedlings of lodgepole pine and up to 15% of Japanese larch affected in a private tree nursery.
Ink spot *Ciborinia whetzelii* (Seav.) Seav.	Trembling aspen	Central Newfoundland Eastern Labrador	Low incidence. Up to 25% of foliage affected in eastern Labrador.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Tamarack	Avalon Peninsula	Damage ranged from light to severe.

Newfoundland and Labrador Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Leaf and shoot blight *Pollaccia elegans* Serv.	Balsam poplar Silver poplar	Eastern Newfoundland Avalon Peninsula	Up to 30% of foliage on seedlings in a commercial tree nursery affected.
Venturia macularis (Fr.) E. Müll. & Arx	Trembling aspen	Western and central Newfoundland, eastern Labrador	30% damage throughout Beothuck Provincial Park in central Newfoundland. Common on aspen regeneration elsewhere..
Leaf spot *Entomosporium mespili* (DC. ex Duby) Sacc.	Hawthorn	St. John's	100% of foliage affected in a private garden.
Marssonina brunnea (Ell. & Ev.) Sacc.	Trembling aspen Lombardy poplar	Avalon Peninsula Eastern Labrador	Severe damage to a small stand of trembling aspen in Labrador. Over 80% of foliage affected in urban areas on the Avalon Peninsula.
Septoria musiva Peck	Balsam poplar	Avalon Peninsula	Over 90% of the foliage affected but incidence low.
Mountain-ash sawfly *Pristiphora geniculata* (Htg.)	American mountain-ash	Western, central, and eastern Newfoundland	Low to high populations. Severe defoliation in western and eastern Newfoundland.
Mourning cloak butterfly *Nymphalis antiopa* (L.)	Willow	Western Newfoundland	High larval count at one location.
Nectria canker *Nectria galligena* Bres.	Golden alder Maple Crabapple	Avalon Peninsula	Numerous stem and branch cankers on several maple trees in urban areas.
Needle blight *Didymascella thujina* (Durand) Maire	Eastern white cedar	Western Newfoundland	New record. 10% of old and new foliage affected.
Needle cast *Hypodermella laricis* Tub.	Tamarack	Central and eastern Newfoundland	10% of the foliage affected on a few trees.
Isthmiella faullii (Darker) Darker	Balsam fir	Eastern Labrador	Light damage in exposed areas.
Rhizosphaera kalkhoffii Bubàk	Colorado blue spruce	Avalon Peninsula	High incidence. 70% of blue spruce seedlings affected in a commercial tree nursery.
Needle rust *Chrysomyxa empetri* Schroet. ex Cummins	White spruce	Central Newfoundland	Low incidence. On 90% of the new foliage.
Chrysomyxa ledi de Bary	White spruce Black spruce Blue spruce	Avalon Peninsula	High incidence in a commercial tree nursery at Markland, where up to 80% of the new foliage affected on 100% of the blue spruce trees.
Chrysomyxa ledicola Lagerh.	Sitka spruce White spruce Black spruce Blue spruce	Western and central Newfoundland, Avalon Peninsula	Moderate incidence on the Avalon Peninsula where up to 20% of the new foliage affected on 100% of the Sitka spruce in a planting trial.

Newfoundland and Labrador Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Pucciniastrum epilobii Otth	Balsam fir	Avalon Peninsula Eastern Labrador	Low incidence. 10% of new foliage affected throughout a balsam fir stand in eastern Labrador.
Phomopsis blight *Phomopsis juniperovora* Hahn	Northern white cedar	Avalon Peninsula	Low incidence on ornamentals in urban areas of St. John's.
Poplar serpentine leafminer *Phyllocnistis populiella* Cham.	Trembling aspen	Western and central Newfoundland, eastern Labrador	Damage ranged from light to severe throughout all locations.
Powdery mildew *Podosphaera clandestina.* (Wallr. ex Fr.) Lév.	White birch	Central Newfoundland	Low incidence. 10% of foliage affected.
Quince rust *Gymnosporangium clavipes* (Cke. & Pk.) Cke. & Pk.	Serviceberry	Western Newfoundland	Up to 10% of foliage affected on some trees.
Redlined conifer caterpillar *Feralia jocosa* (Gn.)	Balsam fir Black spruce	Western Newfoundland Eastern Labrador	Low numbers. No significant defoliation.
Rust gall *Gymnosporangium cornutum* Arth. ex Kern	American mountain-ash	Avalon Peninsula	Low incidence.
Satin moth *Leucoma salicis* (L.)	Willow Trembling aspen Silver poplar Balsam poplar	Western, central and eastern Newfoundland	High populations and severe damage to host trees in all locations.
Shot hole *Coccomyces hiemalis* Higgins	Pin cherry European cherry	Avalong Peninsula Eastern Labrador	Over 90% of the foliage affected on young European cherry trees in a commercial tree nursery.
Spruce budmoth *Zeiraphera canadensis* Mut. & Free.	White spruce	Western and eastern Newfoundland	Low numbers and light damage.
Striped alder sawfly *Hemichroa crocea* (Geoff.)	Speckled alder	Western and central Newfoundland	Numerous small infestations recorded throughout western Newfoundland.
Taphrina witches' broom *Taphrina cerasi* (Fckl.) Sadeb.	Pin cherry Cultivated cherry	Avalon Peninsula	Low incidence. 100% of foliage affected on some trees.
Tar spot *Rhytisma salicinum* (Pers.) Fr.	Willow	Eastern Labrador	Moderate incidence.
White-marked tussock moth *Orgyia leucostigma* (J.E. Smith)	Balsam fir	Western Newfoundland	Low numbers and light defoliation.
Willow blight *Fusicladium saliciperdum* (All. & Tub.) Lind.	Willow	Western Newfoundland Burin Peninsula St. John's	Up to 10% of foliage affected on ornamentals in St. John's.

Maritimes Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
Alder flea beetle *Altica ambiens alni* Harr.	Alder	Maritime provinces	Patches of moderate and severe browning along the St. John River Valley to Edmundston and in southwestern New Brunswick; also throughout much of Nova Scotia. Populations increased in eastern Prince Edward Island and browning was severe in the Montague-Cambridge-Roseneath areas of Kings County.
Ambermarked birch leafminer *Profenusa thomsonii* Konow	White birch Wire birch Yellow birch	New Brunswick Nova Scotia	Leaf browning in several areas of the two provinces generally of low intensity, with the exception of birch at one location in Kings County, N.B. where moderate discolouration occurred.
Anthracnose of maple *Kabatiella apocrypta* (Ell. & Ev.) Arx	Red maple Sugar maple	New Brunswick Nova Scotia	Intensity variable in New Brunswick, mostly in the north; severe and moderate browning of sugar maple at Thibodeau Brook, Madawaska Co. Trace to light levels of infection at scattered locations in several counties in Nova Scotia.
Ants *Formicidae*	Conifers	New Brunswick Prince Edward Island	In New Brunswick, 12% of small balsam fir trees killed at North Forks, Queens Co. In Prince Edward Island, high populations continued in newly established plantations.
Ash rust *Puccinia sparganioides* Ell. & Barth.	Ash	Nova Scotia	Chronic severe infection in much of coastal Nova Scotia causing dieback and some tree mortality, most often in urban settings. Infection levels in 1988 were generally lower than in previous years.
Ash yellows	Ash	Maritime provinces	Not found in the Region to date. This disease is present in the United States and is a concern to plant quarantine officials.
Aspen leafrollers *Epinotia criddleana* (Kft.) *Pseudexentera oregonana* (Wlshm.) Darkheaded aspen leafroller *Anacampsis innocuella* (Zell.) Lightheaded aspen leafroller *Anacampsis niveopulvella* (Cham.) Spotted aspen leafroller *Pseudosciaphila duplex* (Wlshm.)	Aspen	Maritime provinces	Leafrolling, mostly of trembling aspen remained common. Leafrolling at Aylesford East, Kings Co., N.S. declined to 35% from 64% in 1987. Trace or light leafrolling elsewhere.
Aspen webworm *Tetralopha aplastella* (Hlst.)	Trembling aspen	Maritime provinces	Very low populations in a few scattered locations, except at Curtis Settlement, Northumberland Co., N.B., where 71% of leaves were rolled and all trees affected.
Atmospheric impurities	White pine	Nova Scotia	Tree crowns, near a tin mine at East Kemptville, Yarmouth Co., showed no signs of the damage reported in 1987.
Bagworm *Thyridopteryx ephemeraeformis* (Haw.)	Spruce	Maritime provinces	No reports in 1988.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Balsam bark weevil *Pissodes dubius* Rand.	Balsam fir White spruce Black spruce Red spruce	Maritime provinces	Common on dead and dying balsam fir in New Brunswick (12% of trees affected at 12 locations in six counties), also found on spruces. An average 17% of white spruce affected in Queens Co., P.E.I. (4 locations). Only one sample from Nova Scotia.
Balsam fir bark beetle *Pityokteines sparsus* (Lec.)	Balsam fir	Maritime provinces	Common in weakened trees in New Brunswick; 32% of trees affected near Cranberry Lake, Queens Co., 16% at Shaw Brook, Westmorland Co. Scarce in Nova Scotia and not found in Prince Edward Island.
Balsam fir sawfly *Neodiprion abietis* (Harr.)	Balsam fir Red spruce White spruce	Maritime provinces	Present in very low numbers at scattered locations in Nova Scotia, not reported from the other provinces.
Balsam gall midge *Paradiplosis tumifex* Gagne	Balsam fir	Maritime provinces	Populations generally low throughout except for a few spot infestations at widely separated locations. In New Brunswick infestation levels of 10-20% were found at only 7 of 765 locations; in Nova Scotia only 2% of 366 locations were in the 6-29% infestation category.
Balsam shootboring sawfly *Pleroneura brunneicornis* Roh.	Balsam fir	Maritime provinces	Populations increased and became more widespread in northeastern New Brunswick and in some areas in Nova Scotia; however, damage levels remained low. Few larvae at one location in Prince Edward Island.
Balsam twig aphid *Mindarus abietinus* Koch	Balsam fir	Maritime provinces	Infestations common throughout the Region but damage generally not serious. In New Brunswick 39% of 766 locations and in Nova Scotia 57% of 366 locations were "positive". On "average" 13% of shoots were damaged in New Brunswick and 10% in Nova Scotia.
Balsam woolly adelgid *Adelges piceae* (Ratz.)	Balsam fir	Maritime provinces	Populations appear to be on the rise in New Brunswick as indicated by more frequent stem attack; stable in coastal areas of Nova Scotia, expressed as twig attack. Not observed in Prince Edward Island.
Beech bark disease *Nectria coccinea* (Pers. ex Fr.) Fr. var. *faginata* Lohm., Wats. & Ayers Beech scale *Cryptococcus fagisuga* Lind.	Beech	Maritime provinces	Cankered trees remain common throughout the Region.
Birch casebearer *Coleophora serratella* (L.)	Alder White birch	Maritime provinces	Various levels of foliage browning, often moderate or severe in patches of trees, in many areas of the Region. Population levels considerably higher than in 1987 in New Brunswick and Prince Edward Island.
Birch leafminer *Fenusa pusilla* (Lep.)	Wire birch White birch	Maritime provinces	The intensity of leaf browning increased in Nova Scotia, decreased in New Brunswick, and remained unchanged in Prince Edward Island, compared to 1987. Severe discolouration occurred in only a few areas of Nova Scotia.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Birch sawfly *Arge pectoralis* (Leach)	Yellow birch	Nova Scotia	Light defoliation in only one location.
Birch skeletonizer *Bucculatrix canadensisella* Cham.	White birch	Nova Scotia	More common than in past years. Caused moderate and, in a few cases, severe foliage discolouration in isolated pockets throughout the province.
Black leaf blister *Taphrina dearnessii* Jenkins	Red maple	Maritime provinces	Affected 23% of leaves on 60% of trees at Boularderie East, Victoria Co., N.S. Infections lower elsewhere in the two provinces.
Bruce spanworm *Operophtera bruceata* (Hlst.)	Pin cherry Red maple	Nova Scotia	Single location in each of Cape Breton and Kings counties.
Canker of larch *Potebniamyces coniferarum* (Hahn) Smerlis	Tamarack	Maritime provinces	Five locations in Nova Scotia and one in Prince Edward Island. No report from New Brunswick.
Cedar leafminers *Argyresthia aureoargentella* Brower *Argyresthia freyella* Wlshm. *Coleotechnites thujaella* (Kft.)	Cedar	New Brunswick Prince Edward Island	In New Brunswick, 57% of shoots infested at Latimer Lake, St. John Co.; populations low elsewhere. In Prince Edward Island, trees continued to deteriorate in the Wellington, Muddy Creek, and Miscouche areas of southern Prince County.
Cherry blight	Choke cherry Pin cherry	Maritime provinces	Present at varying levels of intensity throughout much of the Region: severe in Kent and Westmorland counties, New Brunswick; moderate and severe in eastern Nova Scotia; and many trees with severe infection in Prince Edward Island.
Cherry casebearer *Coleophora pruniella* Clem.	Trembling aspen	Maritime provinces	Endemic levels throughout the Region.
Cone rusts *Chrysomyxa pirolata* Wint. *Pucciniastrum americanum* (Farl.) Arth.	White spruce Red spruce	Maritime provinces	*C. pirolata* destroyed 23% of red spruce cones at a location in western Nova Scotia but was uncommon elsewhere. *P. americanum* was common throughout, especially in Nova Scotia on white spruce. All cones infected and 36% destroyed by multiple infection in an area of Cape Breton Island.
Conifer aphids *Cinara* spp.	Conifers	Maritime provinces	Populations declined to low levels.
Deer browsing	Red pine Red spruce	New Brunswick Nova Scotia	Damage on a few red pine at Caribou Depot, Restigouche Co., N.B. Light browsing in Nova Scotia on red pine at Halfway River, Annapolis Co., and on red spruce at East Kemptville, Yarmouth Co.
Deterioration of cedar	Cedar	New Brunswick	Condition of cedar trees in Charlotte and St. John counties continued to improve in 1988. Thin crowns with dead branches were still evident; damage by cedar leafminer and brown cedar leafminer was light. Initial cause of the deterioration remains uncertain.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Dieback	White birch Red maple	Nova Scotia	Crown dieback of red maple at Oak Park, Shelburne Co. and red maple and white birch at Beaver River, Yarmouth Co. continued but at a much reduced rate. Trees are under stress in wet sites with open exposures.
Diplodia tip blight *Sphaeropsis sapinea* (Fr.) Dyko & Sutton	Red pine Austrian pine	Nova Scotia	Present on a few ornamental trees in Queens, Lunenburg, and Yarmouth counties.
Eastern blackheaded budworm *Acleris variana* (Fern.)	Balsam fir White spruce	Maritime provinces	Present in very low numbers in New Brunswick and Nova Scotia. No reports from Prince Edward Island.
Eastern dwarf mistletoe *Arceuthobium pusillum* Peck	Spruce	Maritime provinces	Affected 44% of white spruce trees at Doctors Brook, Antigonish Co., N.S.; uncommon elsewhere.
Eastern spruce gall adelgid *Adelges abietis* (L.)	Red spruce White spruce	Maritime provinces	Trace to light infestation levels. Highest infestations were 36% of shoots affected at The Rocks, Charlotte Co., N.B.; 23% at Robert Brook, Inverness Co., N.S.; and 13% at Goose River, Kings Co., P.E.I.
Eastern tent caterpillar *Malacosoma americanum* (F.)	Apple Cherry	Maritime provinces	Populations generally low in New Brunswick and Nova Scotia, although more common in southern New Brunswick than in 1987. Not found in Prince Edward Island.
Elm leaf aphid *Tinocallis ulmifolii* (Monell)	Elm	New Brunswick	Outbreak reported at Fredericton, York Co. in 1987, collapsed.
Elm leaf beetle *Pyrrhalta luteola* (Mull.)	Elm	New Brunswick	Trace foliage discolouration at Fredericton, York Co.
Elm leafminer *Fenusa ulmi* Sund.	Elm English elm Rock elm	Maritime provinces	Various intensity levels throughout, wherever exotic elms are present. Moderate to severe leaf browning common in Nova Scotia and Prince Edward Island.
European pine sawfly *Neodiprion sertifer* (Geoff.)	Scots pine Austrian pine Mugho pine Red pine	Maritime provinces	Moderate defoliation on 20% of Scots pine at Clyde River; light defoliation of Austrian pine at North Winslow; of Scots pine at Cavendish; found on a single red pine in a plantation at Mount Albion, all in Queens Co., P.E.I. In Nova Scotia, found on red pine and Mugho pine at four locations. No reports from New Brunswick.
European pine shoot moth *Rhyacionia bouliana* (D. & S.)	Red pine	Maritime provinces	Populations low throughout the Region; the highest level of shoot damage was 13% at Maitland, Lunenburg Co. in Nova Scotia; 13% at Auburn, Queens Co. in Prince Edward Island.
European spruce sawfly *Gilpinia hercyniae* (Htg.)	Spruce	Maritime provinces	Populations remained low throughout the Region.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Fall cankerworm *Alsophila pometaria* (Harr.)	Hardwoods	Maritime provinces	Populations remained low throughout following the 1987 collapse. Light defoliation of mature elms occurred at Montague, Kings Co., P.E.I.
Fall webworm *Hyphantria cunea* (Drury.)	Deciduous species	Maritime provinces	Scattered roadside nests in parts of southern New Brunswick, throughout Nova Scotia (particularly the central and western counties), and throughout much of Prince Edward Island. Populations increased in Prince and Queens counties.
Fir coneworm *Dioryctria abietivorella* (Grt.)	Balsam fir White spruce	Nova Scotia	Trace damage to balsam fir and white spruce cones at locations in Colchester and Inverness counties. At South Cape Highlands, Inverness Co., 5% of the cones damaged on 40% of balsam fir.
Flat leaftier *Psilocorsis reflexella* Clem.	Trembling aspen Largetooth aspen White birch Red oak	Maritime provinces	Trace or light leaf tying in all three provinces. Highest levels recorded were: 10% of leaves on 60% of trembling aspen in Queens Co., N.B.; 40% of red oak leaves tied in an area in Shelburne Co., N.S.; only a few larvae in Prince Edward Island.
Flooding	White cedar	New Brunswick	Roadside cedar trees were killed along a 250 metre stretch by small stream flooding at Fielding, Carleton Co.
Forest tent caterpillar *Malacosoma disstria* Hbn.	Hardwoods	Maritime provinces	Populations remained very low throughout the Region.
Foureyed spruce bark beetle *Polygraphus rufipennis* (Kby.)	Black spruce Red spruce White spruce	Maritime provinces	Found at eight scattered locations in New Brunswick with an average of 10% of trees affected. A few beetles collected in Nova Scotia, none in Prince Edward Island.
Frost damage	Conifers Hardwoods	New Brunswick Nova Scotia	Frost damage severe and widespread in northern New Brunswick on balsam fir and spruce: all new white spruce shoots killed in an open growing area of 3-4 ha at LeClerc, Restigouche Co.; balsam fir foliage severely damaged at Kedgwick River, Restigouche Co. and near Nictau Lake, Northumberland Co.; moderate and light shoot damage in many other areas of the Province. In Nova Scotia, an average of 6% of white spruce and an average of 3% of balsam fir shoots damaged: at South Cape Highlands, Inverness Co., 44% of white spruce shoots killed; light and trace damage on red spruce, red maple, yellow birch, and pin cherry at several other locations.
			River, Kings Co., and scattered ornamentals at Breadalbane, Queens Co., infected on Prince Edward Island.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Greenheaded spruce sawfly *Pikonema dimmockii* (Cress.)	Spruce	Maritime provinces	Populations low throughout the Region.
Greenstriped mapleworm *Dryocampa rubicunda rubicunda* (F.)	Red maple	Maritime provinces	Populations low in all three provinces.
Hail damage	Red maple Trembling aspen	Nova Scotia	Moderate damage to red maple at Lantz, Hants Co. Trembling aspen trees over 4-100 ha near Lake George, Kings Co., have thin crowns as a result of hail damage suffered in 1987.
Ink spot *Ciborinia whetzelii* (Seaver) Seaver	Trembling aspen	New Brunswick	Low levels of infection at a few scattered locations.
Jack pine budworm *Choristoneura pinus pinus* Free.	Jack pine	Maritime provinces	Endemic levels throughout the Region.
Larch casebearer *Coleophora laricella* (Hbn.)	Larch	Maritime provinces	Populations remained generally low and caused only trace or light needle discolouration in the three provinces. Moderate browning occurred only in a few small patches of trees in Nova Scotia.
Larch needleworm *Zeiraphera improbana* (Wlk.)	Tamarack	Nova Scotia	Few larvae at one location each in Cape Breton and Inverness counties.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Japanese larch Tamarack	Maritime provinces	Severe defoliation on an experimental Japanese larch plantation, at MacDonald's Corner, Queens Co., N.B., and on larch in an area in Prince Co., P.E.I. No reports from Nova Scotia.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Trembling aspen Wire birch	Maritime provinces	No reports in 1988.
Leaf and twig blight of aspen *Venturia macularis* (Fr.) E. Muell. & Arx	Trembling aspen Largetooth aspen Balsam poplar	Maritime provinces	Common throughout the Region; shoot damage averaged 16% in New Brunswick (23 locations, highest 62%), 4% in Nova Scotia (29 locations, highest 21%) and "light only" in Prince Edward Island.
Leaf blister *Taphrina carnea* Johanson	White birch Yellow birch	New Brunswick Nova Scotia	Moderate infection in Fundy National Park, Albert Co., N.B. (63% of white birch leaves affected) and at Donahue Lake, Guysborough Co., N.S. (36% of yellow birch leaves affected). Light or trace infection in a few other areas in the two provinces.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Leaf blotch of horse chestnut *Guignardia aesculi* (Peck) V.B. Stew.	Horse chestnut	Maritime provinces	Severe leaf browning common throughout Nova Scotia with both intensity and incidence increased from 1987 levels. Infection levels unchanged in New Brunswick with light foliage browning wherever the host is found. No report from Prince Edward Island.
Leafroller on birch *Caloptilia* sp.	White birch Wire birch Yellow birch	New Brunswick Nova Scotia	Leafrolling light throughout New Brunswick, an increase from trace in 1987. Found only at two locations in Nova Scotia.
Leaf rust *Melampsora abietis-canadensis* C.A. Ludwig ex Arth.	Trembling aspen	Nova Scotia	Caused light infection (13%) on 20% of trees in an area in Cumberland County.
Leaf spot of poplar *Drepanopeziza tremulae* Rimpau	Trembling aspen Largetooth aspen	New Brunswick Nova Scotia	Severe leaf browning in parts of Kent, Northumberland, and Queens counties in New Brunswick. Browning of all leaves on all trees at Smith Cove, Digby Co. and Parrsboro, Cumberland Co.; almost as severe at Lumsden Dam, Kings Co. in Nova Scotia. Widespread elsewhere in much of the province with intensity of browning much higher than in 1987.
Lesser aspen webworm *Meroptera pravella* (Grt.)	Trembling aspen	Maritime provinces	Not found in 1988.
Lesser maple spanworm *Itame pustularia* (Gn.)	Red maple	Maritime provinces	Populations very low throughout the Region.
Maple leafroller *Sparganothis acerivorana* MacK.	Red maple Sugar maple	Maritime provinces	Moderate leafrolling on red maple at Middle River, Gloucester Co., N.B. Light or trace leafrolling elsewhere in the Region. No leafrolling at Central Bedeque, Prince Co., where it was severe in 1987.
Mites *Oligonychus milleri* (McGregor)	Jack pine Red pine	Maritime provinces	All needles discoloured on all red pine trees in a plantation in the Stanley Management Area, Hants Co., N.S. Populations very low elsewhere.
Oligonychus ununguis (Jacobi)	Balsam fir Red spruce	New Brunswick Nova Scotia	Light or trace discolouration at a few locations.
Mottled and discoloured foliage	Conifers Hardwoods	New Brunswick Nova Scotia	Various levels of foliage discolouration of several coniferous and deciduous species. Cause unknown, but probably varies with location and species. Tree species affected: in New Brunswick - moderate on black spruce, white birch and red maple in Northumberland Co., on sugar maple in Gloucester Co., and on red maple in Albert Co.; in Nova Scotia - severe on black spruce in Victoria Co., on red pine in Yarmouth Co., on red maple in Hants Co., and red spruce in Annapolis, Cumberland and Halifax counties, moderate on eastern white pine

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
			in Queens Co., on balsam fir in Antigonish Co., and on larch in Digby and Hants counties.
Mountain ash sawfly *Pristiphora geniculata* (Htg.)	Mountain ash	Maritime provinces	Populations declined further in New Brunswick, only a few larvae found at Richibucto, Kent Co In Nova Scotia, defoliation was moderate on ornamentals at Sydney, Cape Breton Co. and light at scattered locations. No reports from Prince Edward Island.
Needle casts *Davisomycella ampla* (Davis) Darker	Jack pine	New Brunswick	Moderate infection on two trees at Mt. Hebron, Kings Co.
Lirula macrospora (Hartig) Darker	Red spruce Blue spruce Black spruce White spruce	New Brunswick Nova Scotia	Moderate or light at a few scattered locations in New Brunswick; common throughout Nova Scotia at low levels of intensity.
Lirula nervata (Darker) Darker	Balsam fir	New Brunswick Nova Scotia	At low infection levels at a few locations.
Needle rusts		Maritime provinces	Present throughout but only at low incidence levels.
Melampsora abieti-capraearum Tub. *Pucciniastrum epilobii* Otth *Uredinopsis* sp.	Balsam fir		
Pucciniastrum vaccinii (Wint.) Joerst.	Hemlock		
Melampsora medusae Thuem.	Larch Trembling aspen		
Coleosporium asterum (Diet.) Syd. *Coleosporium viburni* Arth.	Jack pine Red pine		Severe infection of 80% of jack pine in young plantation in Northumberland Co. N.B.
Chrysomyxa ledi (deBary) *Chrysomyxa ledicola* Lagerh.	Black spruce Red spruce White spruce		Very low levels.
Northern cedar bark beetle *Phloeosinus canadensis* Sw.	Cedar	New Brunswick	Few red trees in the areas of Carleton County where they were very noticeable in 1987.
Northern pitch twig moth *Petrova albicapitana* (Busck)	Jack pine Scots pine Lodgepole pine	Maritime provinces	Widespread at low populations in jack pine plantations in New Brunswick and Nova Scotia. Considerable damage in a lodgepole pine plantation at the Acadia Forest Experimental Station, Sunbury Co., N.B. with 10% tree mortality; 56% of jack pine trees affected in an area northwest of Caledonia, Guysborough Co. No records from Prince Edward Island.
Oak leafroller *Pseudexentera cressoniana* (Clem.)	Red oak	Nova Scotia	Moderate or severe defoliation of oak over 22 800 ha in western Nova Scotia and moderate defoliation of few trees in southern New Brunswick. Repeated defoliation in Nova Scotia is causing serious tree deterioration: of 931 trees assessed at
Oak leaf shredder *Croesia semipurpurana* (Kft.)			

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
			35 locations 5% were dead, 63% had varying degrees of branch dieback, 22% had twig dieback, and less than 10% were healthy. Average tree defoliation in 1988 was 69%, 15% higher than in 1987. Oak leafroller was by far the more common of the two insects.
Oak leaf rust *Cronartium quercuum* (Berk.) Miyabe	Red oak	New Brunswick	First found in the Maritimes in 1988.
Oblique-banded leafroller *Choristoneura rosaceana* (Harr.)	Trembling aspen Yellow birch White birch	Maritime provinces	Few rolled leaves at scattered locations in New Brunswick and at one location in Kings Co., Prince Edward Island. No reports from Nova Scotia.
Ocean salt spray	Spruce Hardwoods	Maritime provinces	Moderate to severe foliage browning at Ste. Anne-de-Kent, Kent Co., N.B.; severe browning of white spruce between LaButteurse and Cornery Brook, Inverness Co., N.S., where light foliage discolouration of hardwoods also occurred. In Prince Edward Island National Park, the sides of trees exposed to the Gulf of St. Lawrence have no foliage. High on-shore winds blowing salt spray clouds ashore on a clear day were observed.
Orangehumped mapleworm *Symmerista leucitys* Francl.	Beech	Nova Scotia	Populations very low; the only records in the Region in 1988 were a single adult in the light trap and a single larva in Kejimkujik National Park, N.S.
Pepper-and-salt moth *Biston betularia cognataria* (Gn.)	Tamarack Red maple	Nova Scotia Prince Edward Island	Trace defoliation at only one location in each of the two provinces.
Pine bark adelgid *Pineus strobi* (Htg.)	Pine	New Brunswick Nova Scotia	Widely distributed and common, causing light infestations at scattered locations in New Brunswick and Nova Scotia.
Pine leaf adelgid *Pineus pinifoliae* (Fitch)	White pine Red spruce	Nova Scotia	Infestations in 1987 in many parts of western Nova Scotia resulted in an average of 21% white pine shoot mortality (range 0 to 76% at 104 locations assessed). New gall formation on red spruce averaged 3% (range 0 to 13%).
Pinkstriped oakworm *Anisota virginiensis virginiensis* (Drury)	Red oak	Maritime provinces	No reports in 1988.
Poplar leaf-folding sawfly *Phyllocolpa* sp.	Trembling aspen	Maritime provinces	Populations increased from 1987 levels in New Brunswick and Prince Edward Island, but decreased in Nova Scotia; an average of 21% of leaves affected in N.B. (29 locations), 4% in N.S. (33 locations), and 13% in P.E.I. (8 locations). The number of trees affected at these locations averaged 71%, 64% and 51%, respectively.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Poplar leafmining sawfly *Messa populifoliella* (Town.)	Trembling aspen	Maritime provinces	In New Brunswick, severe or moderate leaf damage in areas of Kings and Restigouche counties and on ornamentals in Fredericton, York Co. Moderate leafmining at Duvar, Prince Co., P.E.I. No records from Nova Scotia.
Poplar petiolegall moth *Ectoedemia populiella* Busck	Trembling aspen	Nova Scotia Prince Edward Island	Found at six locations in four counties in Nova Scotia; 61% of leaf petioles affected at Maryvale, Antigonish Co., 53% at Four Mile Brook, Pictou Co., and 51% at Athol, Cumberland Co. One location each in Kings and Queens counties, Prince Edward Island.
Poplar serpentine leafminer *Phyllocnistis populiella* Cham.	Trembling aspen	Maritime provinces	Populations were very high, intensely so in northern New Brunswick and spread towards the south. Generally low levels in Nova Scotia and very low in Prince Edward Island. An average of 43% of the leaves on 91% of the trees were affected in northern New Brunswick.
Porcupine damage	Balsam fir Jack pine Tamarack Red pine White pine	New Brunswick Nova Scotia	Damage common throughout New Brunswick and Nova Scotia. 3-44% of trees were damaged in seven counties in N.B., the most damage occurring on jack pine at Tracadie Camp, Gloucester Co. In Nova Scotia, damage ranged from 4 to 92% in nine counties, the highest figure in a jack pine plantation at Indian Fields, Shelburne Co., and 70% in a red pine plantation at Lake Joli, Digby Co.
Premature needle loss	Black spruce	New Brunswick	Premature loss of the previous year's foliage continued in 1988 in black spruce plantations in Victoria and Madawaska counties, but at slightly reduced levels: 52% of one-year-old needles lost in the spring of 1988 compared to a 75% loss in 1987.
Rabbit damage	Balsam fir Tamarack Red pine	Maritime provinces	Moderate damage to balsam fir at Lepreau Falls, St. John Co.; light elsewhere in a few other areas in New Brunswick and Nova Scotia. No reports from Prince Edward Island.
Ragged spruce gall adelgid *Pineus similis* (Gill.)	Red spruce White spruce	Maritime provinces	Scattered and generally of light intensity in the Region, the highest occurrence being 21% of red spruce shoots infested at Graywood, Annapolis Co., N.S. and 9% of shoots affected on 50% of white spruce at Riverdale, Queens Co., P.E.I.
Redheaded jack pine sawfly *Neodiprion virginiana* complex	Jack pine Scots pine	Maritime provinces	No reports in 1988.
Red flagging of balsam fir *Fusicoccum abietinum* (Hartig) Prill. & Delacr.	Balsam fir	Nova Scotia	Observed on 56% of trees at Bericham, Colchester Co.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Red pine cone beetle *Conophthorus resinosae* Hopk.	Red pine		No reports in 1988.
Red shoots	Balsam fir	New Brunswick Nova Scotia	Discoloured shoots observed on 40% of trees at Upper Tetagouche Lake, Restigouche Co. N.B., and noted on scattered roadside trees in Hants, Halifax, and Cumberland counties. The cause is unknown.
Red spruce adelgid *Pineus floccus* (Patch)	Red spruce Black spruce	New Brunswick Nova Scotia	Light damage at seven locations in New Brunswick and at four in Nova Scotia. Highest level of infestation found at Goshen, Albert Co., N.B., where 21% of red spruce shoots were affected.
Resin flow	White spruce	Prince Edward Island	Pitch flow is a continuing problem on the underside of white spruce branches in southern Kings County. Cause unknown.
Roadside salt damage	Conifers	New Brunswick Nova Scotia	Foliage discolouration severe or moderate in many areas of New Brunswick and Nova Scotia. Most visibly affected species were, as usual, white pine and red pine.
Saddled prominent *Heterocampa guttivitta* (Wlk.)	Sugar maple	Maritime provinces	Endemic levels.
Satin moth *Leucoma salicis* (L.)	Silver poplar Carolina poplar	Maritime provinces	Populations generally down in New Brunswick, severe defoliation only at St. Leonard, Madawaska Co. on silver poplar. Only trace defoliation of Carolina poplar at New Maryland, York Co., where severe defoliation occurred in 1987. In Prince Edward Island, severe defoliation on scattered silver poplar trees at Murray Harbor and Belfast, Kings Co., and Cherry Valley, New Haven, and Marshfield, Queens Co. Moderate defoliation at St. Peters, Kings Co., and Kensington, Prince Co. No noticeable defoliation found in Nova Scotia.
Snow damage	Conifers	Maritime provinces	Damage to 40% and 32% of red pine trees in Taylor Lake and Cox Brook road, respectively, in Pictou Co., N.S. Scattered damage elsewhere in the Region.
Spearmarked black moth *Rheumaptera hastata* (L.)	White birch	New Brunswick	Encountered at four scattered locations at low levels.
Spittlebugs			
Aphrophora sp.	Conifers	Maritime provinces	Present at low levels, throughout Nova Scotia, two areas in New Brunswick and one location in Prince Edward Island.
Cercopidae	White spruce Balsam fir White birch Red maple Red oak Alder	Nova Scotia	Present in low numbers throughout the Province.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Spring cankerworm *Paleacrita vernata* (Peck)	Elm	Nova Scota	At endemic levels.
Spruce bud midge *Rhabdophaga swainei* Felt	Black spruce Red spruce White spruce	Maritime provinces	Populations low but widespread throughout.
Spruce bud scale *Physokermes piceae* (Sch.)	Black spruce Red spruce White spruce	Maritime provinces	Common throughout Nova Scotia, especially on red spruce. 78% and 66% of shoots infested at Cape Blomidon, Kings Co. and south of Mink Lake, Yarmouth Co., respectively. Widespread but only at trace level in Westmorland and Albert counties, New Brunswick; found at one location in Prince Edward Island.
Spruce cone maggot *Strobilomyia neanthracina* [*Hylemya anthracina* (Czerny)]	Red spruce *White spruce*	Nova Scotia	Common in Province. Damage generally *low. 46% and 35% of white spruce* cones were affected at Whycocomagh, Inverness Co. and north of Earltown, Colchester Co., respectively.
Spruce coneworm *Dioryctria reniculelloides* Mut. & Mun.	Spruce	Maritime provinces	Populations remained generally low throughout Region. However, 52% of white spruce cones were damaged, in association with spruce budworm damage, at Cavendish, Queens Co., P.E.I.
Spruce gall adelgid *Adelges lariciatus* (Patch)	Red spruce White spruce Larch	Maritime provinces	Present at low numbers at one location in New Brunswick (light damage) and at scattered locations in Nova Scotia (trace damage). No reports from Prince Edward Island.
Spruce twig aphid *Mindarus obliquus* (Cholodk.)	Black spruce Red spruce White spruce	Maritime provinces	Light to moderate damage with an average of 9% of shoots affected at 23 locations in 15 counties in Nova Scotia. Highest infestation recorded at Middle Sackville, Halifax Co., where all red spruce trees were affected and 63% of the shoots damaged. Found at one location each in the two other provinces.
Sugar maple borer *Glycobius speciosus* (Say)	Sugar maple	Maritime provinces	Present throughout the Region at varying levels of incidence.
Sulphur dioxide damage	Conifers Hardwoods	New Brunswick	Trees continued to deteriorate in natural stands and some mortality of conifers occurred in a plantation near a base metal smelter in Gloucester County.
Tar spot of maple *Rhytisma acerinum* (Pers. ex St. Amans) Fr.	Maple	New Brunswick Nova Scotia	Found at scattered locations. Infected leaves averaged 20% and 29% in New Brunswick and Nova Scotia, respectively. As many as 92% and 88% of leaves infected at Neils Harbor, Victoria Co. and Ogden, Guysborough Co., respectively, in Nova Scotia.
Uglynest caterpillar *Archips cerasivorana* (Fitch)	Cherry Alder Apple	Maritime provinces	Common in all three provinces, with nests present in numerous areas. In New Brunswick, nest counts decreased towards

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
	Red oak Sugar maple		the north from "too numerous to count" at New Maryland, York Co. to 30/100 m^2 at Comeau Ridge, Madawaska Co. In Nova Scotia, populations at about 1987 levels with frequent counts of 25/100 m^2. In Prince Edward Island, counts averaged 29/100 m^2 at seven locations in Prince County with a maximum of 71/100 m^2 at Duvar.
Wax filament scale *Xylococculus betulae* (Perg.)	White birch Beech	Maritime provinces	Infestations generally light in both New Brunswick and Nova Scotia except at three locations in Fundy National Park where more than three quarters of birch trees were infested. No reports from Prince Edward Island.
Weevil damage *Strophosoma melanogrammum* Forst.	Red pine	Nova Scotia	A general feeder of no previously reported economic importance, the weevil caused severe defoliation in young 2-0 red pine plantations in Cape Breton Co., N.S. In addition to feeding on needles of conifers, young stems are also damaged. Weevils were found on white birch foliage, as well as on conifers.
Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	Jack pine Scots pine Lodgepole pine	New Brunswick Prince Edward Island	Common in jack pine in southern New Brunswick plantations and natural stands and found on lodgepole pine at Acadia Forest Experimental Station. Scots pine Christmas trees at Murray
White pine blister rust *Cronartium ribicola* J.C. Fisch.	White pine	Maritime provinces	Present throughout the Region; 56% of trees affected at North Forks, Queens Co., N.B.
White pine cone beetle *Conophthorus coniperda* (Sz.)	Red pine White pine	Maritime provinces	No reports in 1988.
White pine sawfly *Neodiprion pinetum* Nort.	White pine	New Brunswick Nova Scotia	Populations decreased from 1987 levels. Found only on a few ornamentals at one location each in York Co., N.B. and Inverness Co., N.S.
White pine weevil *Pissodes strobi* (Htg.)	White pine Scots pine Jack pine White spruce Norway spruce Red spruce Blue spruce Black spruce	Maritime provinces	Present in plantations, in natural stands, and on ornamentals throughout the Region, often causing considerable damage, such as 80% of Norway spruce at Rang-Des-Collin, Madawaska Co.; 36% of white pine at Upper Tetagouche Lake, Restigouche Co., N.B.; 80% of white pine south of blockhouse, Lunenburg Co., N.S.; 12% of Norway spruce at Stanhope, Queens Co., P.E.I.
Whitespotted sawyer beetle *Monochamus scutellatus* (Say)	Balsam fir White pine Red pine Jack pine Red spruce White spruce	Maritime provinces	Common throughout the Region. Infested as many as 44% of balsam fir trees at Guitar, Gloucester Co., N.B. and 25% of trees in both Nova Scotia and Prince Edward Island at some locations.

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
	Tamarack		
Willow blight *Venturia saliciperda* Nuesch	Willow	Maritime provinces	Light to moderate browning at scattered locations in the Region, up slightly from the low levels of 1987.
Whitemarked tussock moth *Orgyia leucostigma* (J.E. Smith)	Hardwoods	Maritime provinces	Moderate defoliation in a short stretch along the Trans Canada Highway in southern New Brunswick. Common elsewhere in the Region but defoliation is now light to moderate.
Willow flea weevil *Rhynchaenus rufipes* (Lec.)	Willow	Maritime provinces	Moderate or severe leaf browning of ornamental willows at scattered locations throughout.
Wind damage	Conifers Hardwoods	Maritime provinces	In New Brunswick, a storm in November 1988 uprooted or broke off conifers and some ridgetop hardwoods in the Perth-Plaster Rock area of Victoria Co.; light damage from wind-whipping occurred at Beaconsfield, Victoria Co. In Nova Scotia, summer storms damaged trees in a number of areas: 33% of sugar maple trees had up to 80% of their foliage affected at Belliveau Lake, Digby Co.; moderate damage occurred to red maple at Rocky Mountain, Pictou Co.; hail and strong winds on July 31 damaged foliage of hardwoods and uprooted trees in the Lantz area of Hants Co.; trees, most often red pine, were uprooted in Cumberland, Colchester, Pictou, Antigonish, Victoria and Cape Breton counties. No reports from Prince Edward Island.
Winter drying	Conifers	Maritime provinces	Foliage discolouration was generally less pronounced in New Brunswick and Prince Edward Island than in 1987. However, severe browning of Scots pine Christmas trees occurred at Ste. Anne and Martin in Madawaska Co., N.B. In Nova Scotia, moderate to light discolouration of red pine occurred in areas of Guysborough, Colchester, Halifax, and Yarmouth counties.
Winter moth *Operophtera brumata* (L.)	Basswood	Prince Edward Island	Found only on ornamental basswood at Charlottetown, Queens Co., P.E.I.
Witches' broom on spruce *Chrysomyxa arctostaphyli* Diet.	Black spruce	Nova Scotia	Present on scattered black spruce trees in Queens, Shelburne, and Yarmouth counties.
Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.)	Black spruce Red spruce White spruce	Maritime provinces	Moderate defoliation of black spruce at Lisson Settlement, Kings Co., N.B.; a few larvae at three locations in New Brunswick and 13 locations in Nova Scotia. No reports from Prince Edward Island.
Yellow witches' broom *Melampsorella caryophyllacearum* Schroet.	Balsam fir	Nova Scotia	Few individual brooms on scattered trees in New Brunswick in Christmas tree areas; in Nova Scotia, mostly in areas where

Maritimes Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
			chickweed cover was heavy. Highest infection recorded at Debert, Colchester County, N.S. where 52% of the trees were infected.

Québec Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
Anthracnose *Discula* sp.	Sugar maple	Sainte-Félicité (Matane)*	Approximately 3 ha affected.
Aspen serpentine leafminer *Phyllocnistis populiella* Cham.	Trembling aspen and balsam poplar	Matapedia River basin	Moderate to severe infestation.
		Cascapédia River basin	Small pockets varying from light to severe.
		From Murdochville to Gaspé, along the road	Moderate damage.
		Matane Wildlife Reserve; along Ruisseau des Grosses-Roches; along the Sainte-Anne River, and along Mercier River (Gaspé-Ouest)	Decline in infestation. Pockets of light infestation.
		From Tadoussac to Labrieville, along the road	Foliage severely mined.
		North Shore Administrative Region: Lake Pagé (Manic 5); Manicouagan and Outardes river basins at the Vallant and Antrim rivers; Pistuacanis River basin; along the outlet of Lake Godbout; Lake Walker (north of Port-Cartier)	Damage varied from trace to moderate. A decline in the infestation is observed.
Balsam woolly adelgid *Adelges piceae* (Ratz.)	Balsam fir	Port-Daniel, Lake Fromenteau (Bonaventure)	Two sites had light levels.
		Anse à Valleau (Gaspé-Est)	Trace level.
Beech bark disease *Nectria coccinea* (Pers. ex Fr.) Fr. var. *faginata* Lohm., Wats. & Ayers *Nectria galligena* Bres.	Beech	Mansonville (Brome)	Sites suffered moderate damage.
		Eastern Townships near Lake Denison, Bury, Bulwer, and Cherry River	Four new sites representing damage varying from light to moderate.
		Pointe-à-la-Garde and Sellarsville (Bonaventure)	Two sites of moderate damage, one at Sellarsville and one at Pointe-à-la-Garde. At the latter site, a stand was severely affected.
Birch casebearer *Coleophora serratella* (L.)	White birch	Lake Baillargeon (Gaspé-Est)	75% defoliation.
		Saint-Luc, Mont-Louis (Matane)	Damage to 50% foliage.
		Saguenay River Valley (Chicoutimi)	Moderate defoliation.
		Lake des Commissaires, Saint-Félicien, Dolbeau, La Tuque, and La Croche	Major damage.
Birch leafminer *Fenusa pusilla* (Lep.)	White birch	Lake Ollier (Témiscamingue)	Severe defoliation.
		Lake à Bédard, Granada (Témiscamingue)	Two sites of moderate infestation.
		Saint-Marc-de-Figuery (Abitibi)	Stand severely affected.

Québec Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Brownheaded jack pine sawfly *Neodiprion dubiosus* Schedl.	Jack pine	Abitibi-Témiscamingue, Trois-Rivières, Quebec City and North Shore	Present in natural forest and plantations at trace levels.
Bruce spanworm *Operophtera bruceata* (Hulst)	Sugar maple	Administrative regions of Outaouais, Montreal, and Trois-Rivières	Present in some locations, but no significant defoliation reported.
Cedar leafminers *Argyresthia* spp. *Coleotechnites thujaella* (Kft.)	Eastern white cedar	Eastern townships	Present.
		Lake Memphrémagog (between Knowlton Landing and Vale Perkins)	Stand moderately affected over an area of 25 ha.
		From Cowansville to Dunham	More than 50 ha of cedar stands moderately mined.
Dermea canker *Dermea balsamea* (Peck) Seaver	Balsam fir	Southern Quebec, near Lambton, Saint-Daniel, Saint-Joseph, Stanstead, Sawyerville, and Bromptonville	Found in Christmas tree plantations at trace to moderate levels.
Drought	Hardwoods	Perkins, Buckingham, and Saint-André-Avellin (Papineau)	Hardwoods growing on thin soil and on a mountain were affected by a drought that may result in leaf cast.
Dutch elm disease *Ceratocystis ulmi* (Buism.) C. Moreau	White elm	Pointe-Navarre (Gaspé-Est)	First record of the disease in the Gaspé Management Unit.
		Mistassini River (Saguenay)	New site. A single tree was infected.
Early birch leaf edgeminer *Messa nana* (Klug)	White birch	Saint-Sauveur (Terrebonne)	Foliage moderately mined.
European snout beetle *Phyllobius oblongus* (L.)	Sugar maple	South of the Beauce Management Unit	Regeneration ravaged by adult beetles.
Fall cankerworm *Alsophila pometaria* (Harr.)	Red maple	Champlain (Champlain)	Population increase.
	Silver maple	Île aux Vaches and Lake Saint-Pierre (Berthier)	Major decline.
	Sugar maple	Sainte-Véronique (Labelle)	Present.
	Manitoba maple	Along the Assomption River, from Assomption to Joliette	Defoliation varying from trace levels to severe. Third year of infestation.
Gray willow leaf beetle *Tricholochmaea decora* (Say)	Willow, poplars	Administrative region of Abitibi-Témiscamingue	100% defoliation at several sites.
Jack pine budworm *Choristoneura pinus pinus* Free.	Jack pine	Abitibi-Témiscamingue and Outaouais regions	Pheromone trap network comprising 20 sites. Approximately 100 moths were collected at three sites in the vicinity of Fort-Coulonge.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Trembling aspen	Saguenay - Lac-Saint-Jean	Major decline in the infestation, which was in its third year. Trace to light defoliation only.

Québec Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
		North Shore	22 325 ha and 18 825 ha of light to moderate defoliation, respectively, between the des Escoumins and du Sault aux Cochons rivers, and north of the Manic 2 reservoir where defoliation was severe over 325 ha.
		Quebec Region	Near Clermont, 675 ha moderately affected.
Late-frost injury	Spruce, fir	Gaspé Peninsula, Saguenay - Lac-Saint-Jean, Trois-Rivières, Eastern Townships, Montreal, Abitibi, and North Shore	In general, spruce and fir plantations in Quebec suffered light frost injury. In the Eastern Townships, a plantation of Christmas trees located in La Patrie suffered moderate damage. In natural forests on the North Shore, 70% of the fir trees suffered moderate frost damage.
	Maple	Paul Sauvé Park (Deux-Montagnes) and south of the Quebec Region	Several maple stands in the Beauce, Appalachians, and Paul Sauvé Park suffered late frost injury.
	White birch	Murdochville (Gaspé-Ouest)	All white birch trees over an area of roughly 25 ha north of Murdochville were affected by frost.
Leaf spot disease *Septoria musiva* Pk.	Eastern cottonwood	Ile aux Sternes ecological reserve (Saint-Maurice)	Trace levels.
Septoria sp.	White birch	Lake Bazire (Gaspé-Est)	All white birches in the region affected by leaf spot disease.
	Sugar maple	West of Quebec City, north and south of the St. Lawrence River	In maple stands suffering from decline; regeneration and young maples affected.
Maple leaf cutter *Paraclemensia acerifoliella* (Fitch)	Sugar maple	Area south of Drummondville to Sutton	Light to moderate defoliation in 23 maple stands.
Needlecast *Lophodermium seditiosum* Minter, Staley & Millar	Red pine	Saint-Hilarion (Charlevoix-Ouest)	Plantation had all trees moderately affected.
Needle rust *Coleosporium asterum* (Diet.) Syd.	Red pine	Saint-Alexis-des-Monts (Maskinongé)	This 1978 plantation was restocked in 1987. Needle rust affected 61% of the foliage of the trees restocked, a moderate level.
Red-headed jack pine sawfly *Neodiprion rugifrons* Midd.	Jack pine	Abitibi-Témiscamingue, Trois-Rivières, Quebec City and North Shore	Present in natural forest and plantations at trace levels.
Red pine sawfly *Neodiprion nanulus nanulus* Schedl	Red pine	Saint-Antoine-Abbé (Huntingdon)	Pitch pine ecological reserve. Decline in the number of trees affected and colonies detected.
Root rot *Fusarium* sp.	Red pine	Saint-Samuel de Horton (Nicolet)	In a young plantation there was 80% mortality.
	Tamarack, red pine, and jack pine	Vinton (Pontiac)	Mortality in a young plantation.
Cylindrocarpon destructans (Zinssm.) Scholten	Red pine	Sainte-Eulalie (Nicolet)	Young plantation had 20% mortality.

Québec Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Cylindrocladium floridanum Sobers & Seymour	Spruce	Saint-Modeste Nursery (Rivière-du-Loup)	Soil in 127 blocks was sampled in August and September. *C. floridanum* was isolated in 2% of the blocks, *C. destructans* in 75%, and *Fusarium* spp. in 29%. Less than 2% of the plants were affected. *C. floridanum* is also present in the Duchesnay Provincial Nursery (Portneuf).
Scleroderris canker *Gremmeniella abietina* (Lagerb.) Morelet	Jack pine and red pine	Provincial nurseries	Detected (less than 0.1% of seedlings) in four jack pine transplant beds and two red pine transplant beds located in three nurseries. These trees had been treated with a fungicide last year.
Spruce spider mite *Oligonychus ununguis* (Jacobi)	Jack pine	Belcourt (Abitibi)	12% of trees had more than 25% foliage affected.
Strawberry root weevil *Otiorhynchus ovatus* (L.)	Spruce and pine	Provincial nurseries	Insect present in six provincial nurseries. Light damage except in one nursery, where 19% of a bed of 219 000 white spruce seedlings were affected.
Swaine jack pine sawfly *Neodiprion swainei* Midd.	Jack pine	All regions	Endemic levels.
Sweet fern blister rust *Cronartium comptoniae* Arth.	Jack pine	Saint-Ambroise (Chicoutimi)	Moderate damage in the north sector of Saguenay bounded by Saint-Ambroise to the west, Chicoutimi-Nord to the east, and Lake LaMothe to the north.
Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	Jack pine	Sault-au-Mouton and Pointe-des-Monts (Saguenay)	Found at two sites at moderate levels.
White pine blister rust *Cronartium ribicola* J.C. Fischer	Eastern white pine	Sainte-Anne-de-la-Rochelle (Shefford), Armagh, Sainte-Perpétue (L'Islet), Lake Baillargeon (Gaspé-Est), Lake aux Orignaux (Champlain)	Found at moderate levels in an eastern white pine plantation.
White pine weevil *Pissodes strobi* (Peck)	White pine	Lake Baillargeon (Gaspé-Est)	100% of white pine in natural regeneration affected.
Whitespotted sawyer *Monochamus scutellatus* (Say)	Jack pine	Senneterre, Lebel-sur-Quévillon	Stand ravaged by adults.
Willow leafminer *Lyonetia* sp.	Balsam poplar	Sainte-Florence (Matapédia)	Leafminer present on 80% of trees.
		North Shore Administrative Region	Found in association with the aspen serpentine leafminer.
Windfall	Hardwoods and softwood	Lake du Sourd, Lake Lafontaine, Lake Saint-Germain in the Papineau-Labelle Wildlife Reserve (Papineau)	In August, a tornado blew down trees over an area of 421 ha. Sugar maple was the primary species affected.

Ontario Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
Abiotic damage Unknown causes	White spruce Balsam fir	Chapleau District	Unexplained abiotic factors accounted for extraordinary lengthening and shortening of new shoots on 100% of all trees examined in several plantations in the northern portion of the district.
Alder flea beetle *Macrohaltica ambiens* (LeC.)	Alder	Chapleau and Cochrane districts	Moderate to severe defoliation at a few locations.
Alder tubemaker *Acrobasis rubrifasciella* Pack.	Speckled alder	Algonquin Park District	Caused 80% defoliation in the central and southern portion of the district.
American aspen beetle *Gonioctena americana* (Schaeff.)	Trembling aspen Largetooth aspen	North Central Region Northern Region Northeastern Region	Low populations recorded, except in Chapleau, Gogama and Sudbury districts where damage was highly variable and complete defoliation was recorded in some stands.
		Eastern Region	Small groups of host trees sustained 25% to 80% foliar browning at scattered locations.
Anthracnose *Discula umbrinella* (Berk & R. Br.) Morelet	Beech	North Bay District	Low levels of foliar damage (5-10%) noted on 100% of all trees evaluated in Restoule Provincial Park.
Aureobasidium apocryptum (Ell. & Ev.) Hermanides Nijhof	Deciduous species	Eastern Region	Varying degrees of damage occurred to small groups of trees throughout the region.
Armillaria root rot *Armillaria mellea* (Vahl ex Fr.) Kumm.	Pine Black spruce Jack pine	Throughout Geraldton District	Infection rates of <3% were commonly reported in young conifer stands and plantations. A single 2-ha plantation sustained 25% mortality.
Aspen leafblotch miner *Phyllonorycter ontario* (Free.)	Trembling aspen	Northwestern Region	Populations variable; however, in many areas 100% of the leaves infested supported an average 4 mines per leaf.
		North Central Region	Foliar damage ranging from 60-90% occurred on young open growing host trees in the Nipigon, Terrace Bay, Geraldton, and Atikokan districts.
		Northern Region	Severe leafmining occurred to fringe trees in Wickstead Twp., Hearst District. 75-80% foliar damage was recorded on immature aspen across the Chapleau District.
Aspen leafroller *Pseudexentera oregonana* (Wlshm.)	Aspen	Northwestern Region	An area of 1 032 130-ha in the Red Lake District experienced 75-100% defoliation. In the Kenora District 485 ha was moderate to severely affected.
		North Central Region	A total of 2600 ha sustained defoliation levels of 20-30%.
		Hearst District	Moderate-to-severe foliar damage on 7500 ha was mapped along the Kabinakagami, Nagagami, and Kenogami rivers.
Balsam fir sawfly *Neodiprion abietis* complex	Balsam fir	Throughout	Light damage occurred at points in the Northwestern, Northeastern Algonquin, and Eastern regions. Elsewhere populations declined.
Balsam shootboring sawfly *Pleroneura brunnecornis* Roh.	Balsam fir	Blind River District	Small areas of semimature trees suffered 80% shoot kill in Proctor Township.

Ontario Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Beech bark disease *Nectria galligena* Bres.	Beech	Napanee District	A shoreline tree at Presquile Provincial Park was infected with this disease.
Beech scale *Cryptococcus fagisuga* Lindinger	Beech	Southern Ontario	Low population levels at several locations, except Presquile Provincial Park where high populations infested 18% of the host in a 20-ha area.
Birch edgeminer *Scolioneura betuleti* Klug.	European birch	Carleton Place District	New distribution record was noted on a tree in Nepean Twp.
Birch leafminer *Fenusa pusilla* (Lep.)	White birch	Northern Ontario	Natural stands affected in several areas, most notably in the Thunder Bay, Nipigon, and Temagami districts where a total of 710 ha was moderately to severely infested. Also widespread damage to ornamentals.
		Southern Ontario	Various degrees of damage occurred in most urban areas. A 5-ha area of forest was severely affected in Kitley Township, Brockville District.
Black army cutworm *Actebia fennica* (Tausch.)	Spruce	Northern Ontario	Declining numbers of adults caught in the pheromone trapping program. A total of 21, 33, and 104 moths trapped at locations in Kapuskasing, Hearst, and Thunder Bay districts, respectively.
Black canker of willow *Glomerella miyabeana* (Fukushi) v. Arx	Willow	Thunder Bay District	Single location of virtually total defoliation (98-100%) on numerous trees at Chippewa Park, Thunder Bay.
Boxelder leafroller *Caloptilia negundella* (Cham.)	Manitoba maple	Thunder Bay District	Incidence of 100% with 22% average defoliation, city of Thunder Bay.
Bud failure	White spruce Black spruce Balsam fir	Cochrane Kapuskasing and Hearst districts	Unknown abiotic conditions caused severe bud failure (>75%) in the upper crown portions of plantation and nursery stock at a number of locations.
Cedar-apple rust *Gymnosporangium juniperi-virginianae* Schw.	Hawthorn Apple	Napanee and Tweed districts	The aecial stage of this fungus was so prominent on the alternate hosts (100%) that they appeared bright orange.
Cedar leafminers *Argyresthia aureo-argentella* Brower, *A. canadensis* Free., *A. thuiella* (Pack.), and *Coleotechnites thujaella* (Kft.)	Eastern white cedar	Eastern Region	Increased populations caused 70-100% defoliation across almost the entire region.
		Algonquin Region	Defoliation in the 70-90% range occurred in the south part of the Minden District and at scattered points through the Bancroft and Pembroke districts.
		Southwestern Region	Increased numbers caused 30-70% defoliation in many areas of Owen Sound District, with heaviest damage occurring on the Bruce Peninsula. Elsewhere, low populations persisted.
		Central Region	Heavy foliar damage (70-90%) occurred in the north half of Lindsay District; lighter defoliation (30-40%) was reported from several areas of Maple and Huronia districts.

Ontario Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
		Espanola District	Defoliation levels of 30-100% occurred along the south shores of Cockburn and Manitoulin islands.
Comandra blister rust *Cronartium comandrae* Peck	Jack pine	Northwestern Region	Recorded at several plantations with infection rates varying between 1 and 20%.
Dutch elm disease *Ceratocystis ulmi* (Buism.) C. Moreau	Elm	Atikokan District	7% infection rate in the town of Atikokan.
		Dryden District	A new distribution point confirmed when fungus was identified in the town of Dryden.
Early birch leaf edgeminer *Messa nana* (Klug)	White birch	Sudbury District	High populations recurred in McKim and Neelon townships.
		Kenora District	New distribution point recorded on Treaty Island, Lake of the Woods.
Eastern pine shoot borer *Eucosma gloriola* Heinr.	Jack pine Red pine Scots pine	Northern Ontario and Algonquin Region	General increase in population and damage levels experienced across province. Leader damage ranged from 0.7% to a high of 15.3% in plantations sampled.
Eastern tent caterpillar *Malacosoma americanum* F.	Deciduous species	Southern Ontario	High populations recurred in many areas causing moderate to severe damage.
		Northeastern Region	Heavy defoliation reported at points in Sault Ste. Marie, Blind River, Espanola, and North Bay districts.
Elm casebearer *Coleophora limosipennella* (Dup.)	White elm	Eastern Region	Caused 100% foliar damage in Elizabeth Township Brockville District and 60% foliar damage on urban trees in Madoc, Tweed District.
Elm leafminer *Fenusa ulmi* Sund.	White elm	Brockville District	Severe foliar damage (100%) at several locations.
European pine needle midge *Contarinia baeri* (Prell)	Red pine	Carleton Place District	Light defoliation at three locations.
	Scots pine	Blind River District	Foliar damage of 10% in Patton Township.
European pine sawfly *Neodiprion sertifer* (Geoff.)	Scots pine	Lindsay District	Caused 40% defoliation on 2% of genetic trial trees at Orono Forest Station.
	Jack pine Red pine	Sault Ste. Marie, Tweed, and Carleton Place districts	Low populations observed at scattered locations.
European pine shoot moth *Rhyacionia buoliana* (D. & S.)	Jack pine	Espanola District	Light damage to 2% of trees in an 8-ha area in Merritt Twp., and 9% of trees in a 2-ha plantation in Nairn Twp.
European snout beetle *Phyllobius oblongus* (L.)	Deciduous species	Algonquin Park, Bancroft, and Pembroke districts	Defoliation levels of 5-10% common.

Ontario Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Eutypella canker *Eutypella parasitica* Davidson & Lorenz	Sugar maple	Parry Sound District	Noted on 8% of all trees examined in a maple plot in Killbear Provincial Park.
Fall cankerworm *Alsophila pometaria* (Harr.)	Manitoba maple	Northwestern Region	Ornamentals defoliated an average of 40% in Sioux Lookout and 80% in Dryden.
Fall webworm *Hyphantria cunea* (Drury)	Deciduous species	Sioux Lookout District Thunder Bay District	Scattered colonies caused up to 50% foliar damage at several locations.
		Temagami District Kirkland Lake District	Light defoliation more commonly observed than in previous years.
		Huronia District	Occasional light defoliation observed.
		Eastern Region	Defoliation ranged from 10 to 90% in Kitley Twp., Brockville District. Lighter damage recorded in Edwardsburg Twp., Brockville District and Brighton Twp., Napanee District.
		Southwestern Region	10% foliar damage occurred along Hwy. 24 in South Walsingham Twp., Simcoe District.
Fir coneworm *Dioryctria abietivorella* (Grt.)	White spruce	Wawa District	At Rabbit Blanket Lake in Lake Superior Provincial Park 14% of cones examined were infested.
Flat leaftier *Psilocorsis reflexella* Clem.	Red Oak Bur Oak	Parry Sound District	Commonly at low defoliation levels (5-10%) on roadside trees.
	Trembling aspen White oak	Brockville District	High incidence of heavy foliar browning (60-90%) along Leeds and Grenville Co. Rd. 22.
Fomes root rot *Heterobasidion annosum* (Fr.) Bref.	Red pine	Huronia District	Two sites of infected mature plantation trees.
		Simcoe District	A small pocket (0.5 ha) of dead and dying 20-m plantation trees noted in Charlotteville Township.
Frost damage	White spruce	Algonquin Park, Bancroft, and Pembroke districts	Various levels of shoot damage, most prevalent at single location in Fraser Township, Pembroke District where damage averaged 90% on affected individuals.
	White spruce Balsam fir	Sudbury and North Bay districts	Both species frequently sighted suffering 80-100% new shoot mortality.
	Trembling aspen	Lindsay District	Damage on 70% of hybrid stools in the Orono Forest Tree Nursery.
	Black spruce	Dryden District	Frost heaving caused 18% mortality of seedlings in single compartment at the Dryden Forest Tree Nursery.
Gray willow leaf beetle *Tricholochmaea decora* (Say)	Willow	Northern Region	Severe skeletonizing of roadside trees throughout all districts in the region.
Greenstriped mapleworm *Dryocampa rubicunda* (F.)	Red maple	Atikokan and Fort Frances districts	Heavy infestations caused 25% to 100% defoliation.

Ontario Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Hail	Mixed forest	Bancroft District	Moderate to severe foliar damage on 5 292 ha resulting from August hail and windstorm.
		Algonquin Park and Pembroke districts	Severe branch and tree mortality reported on 2 583 ha in the area damaged in 1988.
Heat damage	White spruce Norway spruce White pine	Lindsay District	Unusually warm weather accounted for the loss of thousands of seedlings in and outside of greenhouses at the Orono Forest Tree Nursery.
Hickory leaf spot *Marssonina juglandis* (Lib.) Magnus	Butternut	Carleton Place District	Commonly noted at moderate to severe foliar damage levels on ornamentals at the Agriculture Canada Arboretum in Ottawa.
Hickory twig pruner *Elaphidionoides parallelus* (Newm.)	Red and white oak Bitternut hickory	Eastern Region	Light damage at numerous locations through most of the region.
Ink spot of aspen *Ciborina whetzelii* (Seaver) Seaver	Trembling aspen	North Central Region	Increased incidence of this disease accounted for moderate levels of foliar damage at numerous locations.
		Chapleau District	Reported in Helleyer and Lloyd townships at low damage levels.
Introduced pine sawfly *Diprion similis* (Htg.)	White pine	Fort Frances and Kenora districts	Low numbers at several sites on shoreline trees.
Jack pine sawflies *Neodiprion pratti paradoxicus* Ross *Neodiprion pratti banksianae* Roh.	Jack pine	Eastern Region	Heavy infestations in many areas. Average defoliation ranged upwards to 90%.
		Throughout	Widespread incidence from Pembroke District west to the Fort Frances District. Defoliation generally light.
Jack pine tip beetle *Conophthorus banksianae* McP.	Jack pine	Blind River District	Heavy infestations recurred in Lane and Timbrell townships where up to 68% of the trees were affected.
		Chapleau District	Trees in Hutcheon and Langlois townships affected 60% and 35%, respectively; leader damage 7% at the latter location.
		Gogama District	A single infestation with 60% of trees attacked in Battersby Township.
Larch casebearer *Coleophora laricella* (Hbn.)	European larch	Central Region	Defoliation (75-90%) occurred at two locations in West Gwillimbury Township; lighter damage (40%) reported near Orangeville and in Erin Township, Cambridge District.
		Southwestern Region	Ornamentals sustained up to 75% foliar damage, Aylmer and Simcoe districts.
	Tamarack	North Bay District	10-ha area in Lauder Township defoliated 70-80%.
Larch-poplar rust *Melampsora medusae* Thüm.	Hybrid poplar	Kapuskasing District	High incidence (>75%) of foliar damage in a single compartment at the Bonner Tree Improvement Centre.

Ontario Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
	Tamarack	Cochrane and Hearst districts	A few light infections.
Larch sawfly *Pristiphora erichsonii* (Htg.)	European larch Tamarack	Thunder Bay, Geraldton, and Kapuskasing districts	Low populations causing <5% defoliation reported from one location in each district.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Trembling aspen	Terrace Bay District	A total of 620 ha averaged 50% defoliation in Priske and Strey townships.
Leaf blight on birch *Septoria betulae* Pass	White birch	Terrace Bay and Nipigon districts	Severe browning mapped over an area of 218 019 ha in the southern part of the districts.
Leaf blotch *Guignardia aesculi* (Peck) Stewart	Horse-chestnut	Niagara District	Along the Niagara Parkway 91% of all ornamentals examined averaged 32% foliar damage.
Leaf spot *Phyllosticta minima* (Berk. & Curt.) Underw. & Earle	Red maple	Parry Sound District	Found damaging 25% of all foliage at the acid rain plot in Mowat Township. Also commonly encountered along Highway 520.
Lesser birch casebearer *Coleophora comptoniella* (McD.)	Wire birch	Carleton Place District	Foliar damage of 35% occurred in Murphy's Point Provincial Park.
Linden looper *Erannis tiliaria* (Harr.)	Deciduous spp.	Terrace Bay District	Defoliation ranged from 50-80% within an area of 8 835 ha along the north shore of Lake Superior between the towns of Schreiber and Marathon.
Linospora leaf blight *Linospora tetraspora* G.E. Thompson	Balsam poplar	Kapaskasing, Cochrane, and Hearst districts	Pockets with high numbers of affected trees routinely sighted throughout the districts.
Maple leafcutter *Paraclemensia acerifoliella* (Fitch)	Maple	Eastern Region and Pembroke District	Generally populations were down from 1987. Population levels and defoliation <10% on lower crowns and understorey regeneration.
Maple petiole borer *Caulocampus acericaulis* (MacG.)	Sugar maple	Eastern Region	Several areas of 10-35% leaf loss recorded throughout region.
Maple trumpet skeletonizer *Epinotia aceriella* (Clem.)	Red maple Sugar maple	Napanee District	One 10-ha stand in each of Presqu'ile and Sandbanks Provincial Parks sustained 20-50% defoliation on understorey and lower canopy trees.
Maple webworm *Tetralopha asperatella* (Clem.)	Sugar maple	Huronia, North Bay, and Parry Sound districts	Varying numbers found in scattered stands.
Moose browse	Jack pine	Espanola District	Damage to trees located in a study plot averaged 30% on branches below 2 m on 9% of trees inspected.
Mountain ash sawfly *Pristiphora geniculata* (Htg.)	Mountain ash	Northern Ontario	Varying levels of foliar damage reported. Highest incidence was 80%, with 60% defoliation, in the Atikokan District.
Needle cast *Lophodermium* sp.	Jack pine	Chapleau District	Commonly encountered throughout Island Lake Tree Improvement area at trace damage levels.

Ontario Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
	Red pine	Brockville District	Single occurrence noted at low damage levels (<10%) in Edwardsburgh Township.
		Bancroft and Algonquin Park districts	Two plantations suffered low foliar damage (15%) on 33% of all trees inspected.
Isthmiella faullii (Darker) Darker	Balsam fir	Chapleau District	Low levels of foliar damage (6-25%) noted at scattered locations throughout central portion of district.
Needle rust *Melampsora* sp.	Willow	Chapleau District	Foliar damage averaged 100% on bushes examined in Shoals Provincial Park.
Northern pitch twig moth *Petrova albicapitana* (Bsk.)	Jack pine	Northwestern Region	Infested terminal whorls averaged 12% in a 50 ha plantation near Coli Lake, Red Lake District. Elsewhere infested leaders ranged from 0.7 to 4.7%.
		North Central Region, Sudbury and Espanola districts.	Light (1%) terminal whorl damage observed at several locations.
Northern tent caterpillar *Malacosoma californicum pluviale* (Dyar)	Deciduous species	Northwestern Region	Sporadic heavy defoliation of roadside shrubs in the Fort Frances, Dryden, Kenora, and Sioux Lookout districts.
Oak skeletonizer *Bucculatrix ainsliella* Murt.	Oak	Simcoe District	Low foliar damage (10%) recorded in South Walsingham and Charlotteville townships.
Oak webworm *Archips fervidanus* (Clem.)	Red oak	Sudbury District	Variable amounts of foliar damage recorded in a 0.5 ha area of Lorne Township.
Orange stalactiform blister rust *Cronartium coleosporioides* Arthur	Jack pine	North Central Region	On average 1% of all trees examined at three locations suffered branch infections.
		Dryden District	A single record of a main-stem infection in Aubrey Township.
Phomopsis gall *Phomopsis* sp.	Bitternut hickory Alder	Eastern Region	Caused significant crown damage (45%) at two locations.
Pine engraver *Ips pini* (Say)	Pine	Southern Ontario	Associated with drought-stressed red pine in the Pembroke, Bancroft, Algonquin Park, and Simcoe districts.
Pine false webworm *Acantholyda erythrocephala* (L.)	Pine	Carleton Place District	Increased populations resulted in 96% and 66% defoliation in red pine plantations in Fitzroy and Ramsay townships, respectively.
		Central Region	High populations reported in Oro Township, Huronia District and in Harvey Township, Lindsay District.
		Algonquin Region	A red pine plantation sustained 80% foliar damage in Cardiff Township, Bancroft District whereas 20-25% defoliation occurred in plantations in McMurrich Township, Parry Sound District.
Pine gall weevil *Podapion gallicola* Riley	Red pine	Pembroke, Bancroft Algonquin Park and Huronia districts	Reported at a low incidence level (5-10% of branches affected) from numerous stands.

Ontario Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Pine needleminer *Exoteleia pinifoliella* (Cham.)	Jack pine	Sudbury and Parry Sound districts	Foliar damage ranged from 25 to 70% in two townships.
Pine needle rust *Coleosporium asterum* (Dietel) Sydow	Jack pine Red pine	Northwestern, North Central, Northeastern, and Northern regions	Heavy infections with varied rates of foliar damage at sporadic locations.
		Carleton Place District	Low levels of foliar damage (11%) in single plantation.
		Algonquin Region	Several locations with varying levels of infection (2-33%) and low rates of foliar damage (<10%).
Pine needle sheathminer *Zelleria haimbachi* Busck	Jack pine	Napanee District	Incidence of 100% with foliar damage of 60% in a 15-ha plantation, Ernestown Township.
Pine sawfly *Neodiprion maurus* Roh.	Jack pine	Fort Frances District	Two locations of 80-100% defoliation on regeneration.
Pine spittlebug *Aphrophora cribrata* (Wlk.)	Jack pine	Sioux Lookout and Red Lake districts	Surveys showed <25% of regeneration supported low populations at two separate locations.
Pine tortoise scale *Toumeyella parvicornis* (Ckll.)	Jack pine	Sudbury District	Low levels of foliar damage (20%) on 4% of all 2-m regeneration in a large cutover.
Red band disease *Mycosphaerella pini* Rostrup	Scots pine	Blind River District	Incidence of 43% recorded in Lefroy Township but overall damage light.
Redheaded jack pine sawfly *Neodiprion virginianus* complex	Jack pine	Northern Ontario	Small numbers reported from several locations causing moderate to severe defoliation.
Redheaded pine sawfly *Neodiprion lecontei* (Fitch)	Red pine	Parry Sound District	High populations reported in McMurrich, Ryerson, and Carling townships.
		Sault Ste. Marie and Blind River districts	Defoliation ranging from 15 to 100% occurred at several points east of the city of Sault Ste. Marie.
Red pine cone beetle *Conophthorus resinosae* Hopk.	Red pine	Temagami District	Heavy infestations on shoreline and island stands of Lake Temagami.
Red pine sawfly *Neodiprion nanulus nanulus* Schedl.	Red pine Jack pine	Northern Ontario	Numerous occurrences. Damage levels light.
Rodent damage	White oak	Carleton Place District	Girdling of 87% of all 4-m tall trees in a 0.5-ha plantation in Gloucester Township.
Root rot *Cylindrocladium floridanum* Sob. & C.P. Seym.	Red pine	Eastern Region	Approximately 25% mortality of all stock in single compartment at G. Howard Ferguson Forest Station.

Ontario Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Salt damage	Red pine White pine Scots pine	Parry Sound, Bracebridge, Minden, Sault Ste. Marie, and Blind River districts and Central Region	Moderate to severe foliar damage routinely noted alongside major highways.
Saratoga spittlebug *Aphrophora saratogensis* (Fitch)	Red pine	Pembroke District	Branch mortality of 10-20% in small pockets in Hagarty, Fraser, and Ross townships.
Satin moth *Leucoma salicis* (L.)	Silver poplar	Napanee District	Light defoliation on 30% of the 7-m trees at one location in Tyendinaga Twp.
Sawyer beetles *Monochamus* spp.	Jack pine	Northern Ontario	Varying degrees of damage to standing timber adjacent to cutovers and near log dumps in Ignace, Red Lake, Sioux Lookout, Dryden, Thunder Bay, and Chapleau districts.
Septoria leaf spot *Mycosphaerella populicola* G.E. Thompson	Balsam poplar	Northeastern Region	Occasional heavily infected stands in the Sudbury and Espanola districts.
		North Central Region	Infections widespread and heavy, often exceeding 90% foliar damage.
		Northwestern Region	Most stands suffered moderate levels (70%) of foliar damage in the Red Lake, Sioux Lookout, and Ignace districts.
		Eastern Region	Severe leaf browning and premature leaf drop reported throughout.
		Central Region	A few widespread locations suffered heavy (>75%) foliar damage.
Shoot blight *Venturia macularis* (Fr.) E. Müller & v. Arx	Trembling aspen	Terrace Bay District	Regeneration surveyed in Wiggins Township averaged 15% leader damage.
Solitary oak leafminer *Cameraria hamadryadella* (Clem.)	Bur oak	Espanola District	A single location of 5 ha sustained 80% defoliation, Baldwin Township.
		Aylmer District	Low damage levels (20%) on regeneration in Delaware Township.
Spiny ash sawfly *Eupareophora parca* (Cress.)	Black ash	Chapleau District	Foliar damage averaged 30% in a 3-ha stand in Langlois Township.
Spruce budmoth *Zeiraphera canadensis* Mut. & Free.	White spruce	Terrace Bay and Sault Ste. Marie District	Defoliation averaged 50-75% on individual trees in several townships.
Spruce cone rust *Chrysomyxa pirolata* (Körn.) Winter	White spruce	Espanola District	Damage to current cone crops ranged between 2-12% at a single location in Robinson Township.

Ontario Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Spruce coneworm *Dioryctria reniculelloides* Mut. & Mun.	White spruce	North Central Region	Associated with spruce budworm at locations in Atikokan, Thunder Bay, and Nipigon districts.
Spruce needle rusts *Chrysomyxa ledi* (Alb. & Sch.) de Bary and *Chrysomyxa ledicola* (Peck) Lagerh.	Spruce	Northern Ontario	Infection levels are on a downward trend. Heaviest foliar damage (20%) recorded at a single location in the Geraldton District.
Swaine jack pine sawfly *Neodiprion swainei* Midd.	Jack pine	Northern Ontario	Light defoliation in a 200 ha area in Tretheway Township, Temagami District. Low numbers recorded in Sioux Lookout, Fort Frances, Chapleau, Cochrane, and Atikokan districts.
Sweet fern blister rust *Cronartium comptoniae* Arthur	Jack pine	Northwestern, North Central and Northern regions	At numerous locations at low infection rates (<20%) on main stems.
		Ignace District	Highest rate of infection (10.4%) across the province noted in Furniss Township.
Swiss needle cast *Phaeocryptopus gaeumannii* (Rohde) Petrak	Douglas fir	Carleton Place District	Single plantation with 50% foliar damage noted on 60% of all trees examined.
Tar spot needle cast *Davisomycella ampla* (J. Davis) Darker	Jack pine	Northern Ontario	Numerous locations at widely varying rates of infection and foliar damage.
		Blind River District	Most notable incidence of this fungus recorded in Lane Township where 63% of all trees inspected averaged 24% foliar damage.
Tip blight *Sphaeropsis sapinea* (Fr.) Dyko & B. Sutton	Scots pine	Lindsay District	Severe infections in Darlington and Manvers townships.
	Scots pine Mugho pine Austrian pine	Brockville, Tweed, Napanee, Minden, and Niagara districts	One or more of these species planted as ornamentals or roadside trees heavily infected.
	Red pine Scots pine	Huronia District	Both species affected at low damage levels in nursery compartments of the Midhurst Forest Tree Nursery. Two Scots pine stands in Tiny Township averaged 30% branch mortality.
	Scots pine	Simcoe District	Heavy infections caused 9% tree mortality and 35% crown mortality on 83% of 20 m tall plantation trees (5 ha) in South Walsingham Township.
	Scots pine	Cambridge and Maple districts	This disease continues to be a problem at various infection levels at several locations.
	Red pine	Atikokan District	Incidence of 10% at a single location on regeneration near Caldwell Lake.
Tussock moth *Dasychira* sp.	Scots pine	Simcoe District	Incidence of 80% on 0.5-m tall Christmas trees in South Walsingham Township.

Ontario Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Variable caterpillar *Pyrrhia experimens* (Wlk.)	White spruce	Hearst District	High populations in a 600-ha plantation of a prescribed bur, caused severe damage to the new shoots and buds of recently planted seedlings after the normal food supply of ground cover plants was exhausted.
Walnut caterpillar *Datana integerrima* G. & R.	Black walnut	Southwestern Region	Low levels of foliar damage randomly located through Chatham, Aylmer, and Simcoe districts.
Weevil *Sciaphilus asperatus* Bonsd.	Sugar maple	Bancroft District	Defoliation averaged 80% on regeneration at one location in Wicklow Twp.
Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hirats.	Jack pine	Northwestern Region	Highest recorded incidence of damage reported across northern Ontario was in the Red Lake, Ignace, and Sioux Lookout districts (10-40%).
		North Central Region	Widespread and variable levels of damage reported.
		Northern Region	High infection levels reported in the Chapleau, Kirkland Lake, and Gogama districts (30-40% in some areas).
		Northeastern Region	Noted as a common disease albeit at low levels of damage.
White pine blister rust *Cronartium ribicola* J.C. Fischer	White pine	Chapleau District	High rates of infection noted in Kosny and Neil townships.
		Atikokan District	Along the Premier Lake Road 13% of all natural regeneration inspected was infected.
White pine weevil *Pissodes strobi* (Peck)	Pines and spruces	Northwestern Region	Overall decline in numbers. Highest incidence was 16% leader mortality in black spruce. Less than 5% recorded elsewhere in region.
		North Central, Northern, and Northeastern regions	Generally low populations. Leader mortality ranged from 0.7 to 15.3%. The highest incidence in the province was in Charters Twp, Kirkland Lake District where 31.3% of the leaders were destroyed.
		Southern Ontario	Variable and scattered leader damage. 28% damage occurred at one site in Nepean Twp, Carleton Place District.
Winter drying	White pine Red pine	North Bay, Algonquin Park, Bancroft, and Pembroke districts	Open growing trees averaged 70% foliar damage at numerous locations.
	Eastern white cedar	Niagara, Simcoe, Chatham, and Aylmer districts	Low levels (<10%) of foliar damage to hedgerows and windbreaks at numerous locations.
		Brockville District	Two compartments averaged 50% seedling mortality at the G. Howard Ferguson Forest Tree Nursery.
	Red pine Pitch pine	Blind River District	Light levels (<25%) of foliar damage at several plantations.

Ontario Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Woolly alder sawfly *Eriocampa ovata* (L.)	Alder	Thunder Bay District	Variable rates of foliar damage reported (up to 100%) in rural area surrounding the City of Thunder Bay.
Yellowheaded spruce sawfly *Pikonema alaskensis* (Roh.)	White spruce Black spruce	Northwestern Region	Defoliation of 20% noted on approximately 60% of trees in Tovell Twp, Fort Frances District and low numbers noted at several other areas in the region.
		North Central Region	Defoliation ranged from 20-85% on 25-100% of the trees at several ornamental and forest regeneration sites.
		Northern Region	Variable amounts of defoliation on ornamental and open growing trees.
		Northeastern Region	Low population caused up to 80% defoliation on occasional trees at three locations. Recurring attacks have caused 4% mortality in a 2 ha plantation in East Mills Twp, North Bay District.
		Central Region	Heavy defoliation in Essa Twp., Huronia District.

Pacific and Yukon Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
A mycoparasite *Darluca filum* (Biv.-Bern. ex Fr.) Cast	Alpine fir	Telkwa	New host record; heavily hyperparasitized fir-blueberry rust, *Pucciniastrum goeppertianum* (Kuehn) Kleb.
A needle midge *Contarinia* sp.	Douglas-fir	Cariboo Region	80-100% defoliation of current growth on all age classes east of McLeese Lake, and widespread northeast of Williams Lake.
Ambermarked birch leafminer *Profenusa thomsoni* (Konow)	White birch	Chilliwack	Range extension to coastal British Columbia.
An adelgid *Pineus* sp.	Sitka spruce	Prince Rupert Region	Common but light in pockets throughout region.
An aspen leafroller, probably *Pseudexentera oregonana* (Wlshm.)	Trembling aspen	Greenwood	300 ha defoliated; insect identification pending.
Anthracnose *Gloeosporium* sp.	Dogwood	Vancouver Region	Following severe infections, tree mortality continued on Lower Mainland and eastern Vancouver Island.
Armillaria root rot *Armillaria ostoyae* (Romagn.) Herink	Douglas-fir	Nelson Region	8 to 40% of trees infected in immature to semimature stands throughout region.
	Engelmann spruce, alpine fir	Glacier National Park	Up to 40% of mature trees infected and killed in scattered pockets.
Atropellis canker *Atropellis piniphila* (Weir) Lohman and Cash	Lodgepole pine	Throughout	Severe stem infections in dense growing stands in several locations in the Cariboo region; endemic levels throughout other regions.
Birch leafminer *Fenusa pusilla* (Lep.)	White birch	Terrace	Extension of known range to northwestern and coastal British Columbia.
Birch leaf skeletonizer *Lyonetia saliciella* Bsk.	White birch	Nelson Region	Up to 70% foliage discolored for 14th consecutive year in northern portion of the region.
Black stain root disease *Ceratocystis wageneri* Goheen & Cobb	Douglas-fir	East Kootenay	Common in Armillaria root disease-infected stands along Kinbasket Lake north of Golden.
Conifer weevil *Magdalis gentilis* LeConte	Lodgepole pine	Cariboo Region	Severe defoliation of current year's growth of young trees in scattered areas for second consecutive year.
Cooley spruce gall adelgid *Adelges cooleyi* (Gill.)	Engelmann, Sitka, white spruce and Douglas-fir	All regions	Needle discolouration common in widespread young Douglas-fir stands; galls common on spruce.
	Sitka spruce	Saanichton	First record of damage to Sitka spruce cones.
Cypress tip moth *Argyresthia* sp.	Ornamental cypress	Victoria	Moderate tip dieback common.
Cytospora cankers *Leucostoma kunzei* (Fr.) Munk	Tamarack	Fort Nelson	New host record.
Valsa abietis Fr.	Western larch	Nakusp, Greenwood	New host record.

Pacific and Yukon Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Dieback fungus *Tympanis laricina* (Fckl.) Sacc.	Lodgepole pine	Smithers Landing	New host record.
Dime canker *Durandiella pseudotsugae* Funk	Douglas-fir	Nakusp	Cankers common on immature trees over 40 ha at Wilson Lake.
Douglas-fir beetle *Dendroctonus pseudotsugae* Hopk.	Douglas-fir	Cariboo, Kamloops, Nelson, and Prince George regions	Groups of 2-40 mature trees killed, usually predisposed by drought, root disease or overmaturity.
Douglas-fir coneworm *Dioryctria pseudotsugella* Munroe	Douglas-fir	Kamloops Region	Associated with western spruce budworm defoliation in Thompson River and Okanagan Valley drainages.
Dwarf mistletoes *Arceuthobium americanum* Nutt. ex Engelm.	Lodgepole pine	Cariboo Region	Severe infection on regeneration near cutblock edges on Palmer Lake Road; widespread in Chilcotin.
		Prince George Region	Widespread in southern half of the region.
A. tsugense (Rosendahl) G.N. Jones	Western hemlock	Prince Rupert and Vancouver regions	Scattered throughout coastal host range causing increment loss.
Elm leafminer *Agromyza aristata* Malloch	Elm	Prince George	60% of foliage infested for third consecutive year on city boulevards.
European mistletoe *Viscum album* L. subsp. *album*	Apple	Victoria	Collected at four sites; a first Canadian record, and second for North America.
European pine shoot moth *Rhyacionia buoliana* (D. & S.)	Ornamental pine	Lower Mainland, Victoria, Okanagan Valley	Established in localized urban areas but no increase in numbers since 1981. No evidence in native pines.
Fir engraver beetle *Scolytus ventralis* Lec.	Grand fir	Vancouver Region	Associated with drought-stressed trees in southwestern British Columbia.
Green velvet looper *Epirrita autumnata omissa* (Harrison)	Alpine fir	Prince Rupert Region	Low to moderate populations widespread in southeastern areas.
Larch budmoth *Zeiraphera improbana* (Wlk.)	Western larch	Nelson Region	Trace defoliation at Johnstone Creek Provincial Park; endemic populations.
Larch cankers *Leucostoma kunzei* (Fr.) Munk *Sirodothis* sp.	Tamarack	Ft. Nelson	New host records. Associated with terminal and lateral dieback on up to 50% of trees affected in isolated pockets.
Larch casebearer *Coleophora laricella* (Hbn.)	Western larch	Nelson and Kamloops regions	Moderate defoliation over 485 ha; declined to light at Vernon.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Ornamental larch	Terrace	Infestation and defoliation continued.
		Prince George	Defoliated ornamental larch in city; new distribution record.
	Tamarack	Prince George Region	Light defoliation near Yukon border.
		Yukon Territory	Active populations for the second consecutive year at Francis Lake and Tungsten Road area.

Pacific and Yukon Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
	Western larch	Nelson Region	Light to moderate defoliation on 500 ha near Fernie and Granby River. Cocoon parasitism high in all areas.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Trembling aspen	Prince Rupert Region	Scattered patchy defoliation throughout western half of region.
		Yukon Territory	1000 ha defoliated between Whitehorse and Takhini River on Alaska Highway.
Leaf spots *Mycosphaerella mycopappi* Funk and Dorworth	Sycamore maple	Rosedale	New host record.
M. populorum G.E. Thomps.	Trembling aspen	Decker Lake	New host record.
Pollaccia borealis Funk	Trembling aspen	Yukon Territory and Prince George Region	Extension of known distribution range of this previously undescribed species.
Septoria alni Sacc.	Sitka alder	Nelson Region	Common throughout region.
Lodgepole pine beetle *Dendroctonus murrayanae* Hopk.	Lodgepole pine	Prince Rupert Region	Tree mortality, scattered in the Peace River Valley.
		Prince George Region	Scattered, common, associated with mountain pine beetle-attacked trees.
Lodgepole terminal weevil *Pissodes terminalis* Hopping	Lodgepole pine	Prince George, Nelson, Cariboo, Prince Rupert regions	Leader mortality in 15 stands averaged 2%, 3%, 4% and 15%, respectively, by region.
Maple leaf scorch (unknown cause, possibly bacteria)	Broadleaf maple	Vancouver Region	Severe foliar browning throughout host range causing branch dieback.
Needle blights *Didymascella thujina* (Durand) Maire	Western red cedar	Vancouver Region	Light infections throughout host range.
Hypodermella laricis Tub.	Western larch	Kamloops Region	Light discolouration patchy from Okanagan Falls north to Sicamous.
		Canal Flats	Moderate defoliation over 650 ha in Kootenay River Valley.
Isthmiella abietis (Dearn.) Darker	Alpine fir	Prince Rupert Region	Light infections on 1-year-old foliage at Dease River.
		Nelson Region	Occasional scattered infections.
I. quadrispora Ziller	Alpine fir	Kispiox	At Elizabeth Lake, associated with infections by fir-fireweed rust, *Pucciniastrum epilobii* Otth.
Rhizosphaera kalkhoffii Bub.	Engelmann spruce	Revelstoke	New host record.
Scirrhia pini Funk & Parker	Western white pine Lodgepole pine	Slocan River Valley north to Revelstoke.	Light to moderate needle discolouration.
Tiarosporella pseudotsugae Whitney, Reid, and Pirozynski	Douglas-fir	Kamloops Region	Discolouration of old foliage on 20% of trees at Mt. Lolo.

Pacific and Yukon Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Needle casts *Davisomycella ampla* (J.J. Davis) Darker	Lodgepole pine	Cariboo Region	Moderate to severe infection of current needles in Chilcotin and southern part of the Cariboo region.
		Penticton	Severe discolouration of 2-year-old foliage at Apex Mountain.
D. medusa (Dearn.) Darker	Lodgepole pine	Lillooet	New host record at Bridge Lake.
D. montana (Darker) Darker	Lodgepole pine	Yukon	New distribution record in Territory; light infections at two locations in southern Yukon.
		Prince George Region	Light infection on regeneration north of Prince George.
Elytroderma deformans (Weir) Darker	Ponderosa pine	Cariboo, Kamloops, Nelson regions	Common and widespread; up to half the older needles infected on some trees.
	Lodgepole pine	Prince Rupert Region	Moderate infections in regeneration in northern portion of region.
Lophodermella concolor (Dearn.) Darker	Lodgepole pine	Kamloops Region	Scattered light to moderate infection in southern and western portion of the region.
		Cariboo Region	Moderate to severe infections in Chilcotin and southern part of region.
		Nelson Region	Moderate to severe infections south of Cranbrook.
		Prince Rupert Region	Moderate infection on current growth in northern half of region.
L. montivaga Petr.	Lodgepole pine	Prince Rupert Region	Moderate infection on current needles in northern half of region.
Meria laricis Vuill.	Western larch	Nelson and Kamloops regions	Infections again common with *Hypodermella laricis* in host range.
Needle Rusts			
Conifer-aspen rust *Melampsora medusae* Thuem.	Douglas-fir	Nelson Region	Light infections on new growth common in interior wet belt zone.
		Prince George Region	Light to moderate infection on seedlings north of Prince George.
Fir-fireweed rust *Pucciniastrum epilobii* Otth	Alpine fir	Prince George, Prince Rupert, Nelson regions	Common in pockets, often affecting most of the current year's growth.
Hemlock-willow rust *Melampsora epitae* Thuem.	Willow	Prince Rupert Region	Early yellowing and leaf drop in Skeena, Kalum and Kitimat River valleys.
		Salmon Arm	100% infection over 500 ha at Woods Landing on Seymour Arm, Shuswap Lake.
Large-spored spruce-Labrador-tea rust			

Pacific and Yukon Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Chrysomyxa ledicola Lagerh.	White spruce	Chetwynd	Light infections on new growth on 100% of trees.
	Sitka spruce	Queen Charlotte Islands	Severe infections.
		Prince Rupert Region	Light infections common.
	Engelmann spruce	East Kootenay	Severe infections of current foliage near upper Kootenay and Beaverfoot rivers.
Small-spored spruce-Labrador-tea rust *C. ledi* de Bary	White spruce	Hudson Hope	Light infections on new growth on 100% of trees.
		Prince Rupert Region	Widespread light to moderate infections in northern half of region.
	Engelmann spruce	West Kootenay	Severe infections, upper Kootenay and Beaverfoot rivers.
Weir's spruce cushion rust *C. weirii* Jacks.	Engelmann spruce	Kimberley	Moderate to severe infection at Redding Creek.
	White spruce	Hazelton	Severe infection on individual trees.
Western pine-aster rust *Coleosporium asterum* (Diet.) Syd.	Lodgepole pine	Nelson Region	Light infection at Nancy Greene Lake and Jaffray areas.
Oak leaf skeletonizer *Bucculatrix ainsliella* Murt.	Oak	Duncan, Surrey	New distribution records outside Vancouver.
Pine leaf adelgid *Pineus pinifoliae* (Fitch)	White spruce	Carmacks, Dawson City	First records from Yukon Territory.
Pine needle sheathminer *Zelleria haimbachi* Bsk.	Lodgepole pine	Kamloops Region	High populations continued from Adams Lake to Salmon Arm.
		Vancouver, Prince Rupert regions	Increased populations caused scattered severe feeding on new shoots of young trees at widespread locations.
		Nelson Region	Light to severe discolouration of current needles over 235 ha in four infestations.
Pine stem rusts *Cronartium coleosporioides* Arth.	Lodgepole pine	Cariboo Region	Light to severe infections widespread in Chilcotin and southern Cariboo.
		Prince George Region	Light infection widespread in southern half of region.
C. comandrae Peck		Prince George Region, Golden	Light infections in scattered stands; 5% mortality in Blackwater River area.
Poplar shoot blights *Venturia macularis* (Fr.) E. Muell. & Arx	Trembling aspen	Prince George Region	Increased moderate to severe infection widespread in northern half of region.
V. populina (Vuill.) Fabric.	Black cottonwood	Prince Rupert Region	Light infection in western part of region.
		Cariboo and Nelson regions	Infection decreased from 1987 levels.

Pacific and Yukon Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Poplar-and-willow borer *Cryptorhynchus lapathi* (L.)	Willow	Prince Rupert Region, Prince George	Chronic populations killed numerous shoots and stems.
Pacific willow leaf beetle *Pyrrhalta decora carbo* (LeC.)	Willow	Nelson Region	Moderate to severe defoliation throughout northern half of West Kootenays.
Pine engraver beetle *Ips pini* (Say)	Lodgepole pine	West Kootenay	Common in Boundary District in conjunction with mountain pine beetle; occasionally causing mortality.
		Cariboo, Prince George regions	Infestations collapsed.
Poplar petiolegall moth *Ectoedemia populella* Bsk.	Trembling aspen	Sidney	New regional record.
Redwood bark beetle *Phloesinus sequoiae* Hopk.	Western red cedar	Vancouver Region	Associated with drought-stressed trees in southwestern B.C.
Root fungus *Cylindrocarpon didymum* (Hart.) Wollenw.	White spruce	Smithers	New host record; fruiting on rotted rootlets.
Saprophyte, or bud fungus *Ramichloridium* sp.	Sitka spruce	Terrace	New regional record; in plantation where 15% of terminals were dead and 60% of trees had affected terminals.
Scleroderris canker *Gremmeniella abietina* (Lagerb.) Morelet	Pines	All regions	Rare and only found as a lower branch saprophyte at four sites between 1968 and 1978; not found where previously collected nor elsewhere in native pines throughout British Columbia.
Silverspotted tiger moth *Lophocampa argentata* (Pack)	Douglas-fir	Vancouver Island, Sunshine Coast	Single colonies causing trace defoliation of single trees at widely scattered locations.
Spruce aphid *Elatobium abietinum* (Wlk.)	Ornamental spruce	Vancouver	Light to severe defoliation in city.
	Sitka spruce	Queen Charlotte Islands	Moderate defoliation of coastal trees.
Spruce broom rust *Chrysomyxa arctostaphyli* Diet.	White spruce	Prince Rupert, Prince George regions, Yukon Territory	Common; one to several perennial brooms per tree causing mortality or top-kill and growth loss.
Spruce bud moth *Zeiraphera* sp.	Sitka spruce White spruce	Vancouver, Prince Rupert regions Yukon Territory	Common at light to moderate levels on current growth. 10% of new growth on all trees in Liard River Valley.
Spruce gall adelgid *Adelges lariciatus* (Patch)	Engelmann spruce	Skimikin	First record west of Rocky Mountains, and a southwestern range extension.
Spruce twig aphid *Mindarus obliquus* (Cholodk.)	Sitka spruce	Saanichton	First record on cones.
Stem canker *Phacidium gaultheriae* Dearn.	Salal	Galiano Island	New host record in British Columbia.
Striped alder sawfly *Hemichroa crocea* Geoff.	Red alder	Queen Charlotte Islands	Moderate defoliation common.
Sunscald	Douglas-fir	Vancouver Region	Stem and branch damage common in young stands and in seed orchards.

Pacific and Yukon Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Swiss needle cast *Phaeocryptopus gaeumannii* (Rohde) Petr.	Douglas-fir	Vancouver Region	Infections in small scattered areas througout the region. Up to 50% needle loss at Golden Ears Provincial Park.
Tip blight *Delphinella* spp.	Alpine fir	Prince Rupert Region	Moderate to severe infection of current growth in central part of region.
Tomentosus root disease *Inonotus* (*Polyporus*) *tomentosus* (Fr.) Gilbn.	Engelmann spruce	Nelson Region	Severe infection in mature blowdown near Rock Creek.
	White spruce	Prince George region	5% infection in one of nine younger stands. Widespread in mature stands.
Warren's root collar weevil *Hylobius warreni* Wood	Lodgepole pine	All regions	Less than 1% mortality; common in young plantations.
Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hiratsuka	Lodgepole pine	All regions	Branch and stem galls common throughout host range.
Western hemlock looper *Lambdina fiscellaria lugubrosa* (Hulst)	Western hemlock	Vancouver Region	Infestation in Jervis Inlet collapsed.
Western pine beetle *Dendroctonus brevicomis* LeConte	Ponderosa pine	West Kootenay	Scattered mortality continued in Boundary and Arrow districts.
Western pine shoot borer *Eucosma sonomana* Kft.	Ponderosa pine	West Kootenay	Minor twig dieback between Christina Lake and Grand Forks.
Western winter moth *Erannis tiliaria vancouverensis* Hulst	Birch, maple, poplar, willow	Kamloops, Vancouver regions	Up to 75% defoliation widespread in deciduous stands.
Winter moth *Operophtera brumata* (L.)	Garry oak, maple, fruit trees	Vancouver Island	Reduced populations, trace to light defoliation in scattered patches on southeastern part of Island.

Northwest Region

Insects, Disease, or Damage	Host(s)	Location	Remarks
American aspen beetle *Gonioctena americana* (Schaeff.)	Aspen	Alberta Saskatchewan Manitoba	Low populations in many regeneration areas.
Aphids, open-feeding several species	Many hosts	Alberta NWT	High populations common on native forest regeneration, in plantations, and on urban plantings.
Armillaria root rot *Armillaria ostoyae* (Romag.) Herink	Many hosts	Alberta Saskatchewan Manitoba NWT	Variable degrees of infection noted in most areas inspected. Also present in many plantation sites.
Ash flower gall mite *Aceria fraxiniflora* (Felt)	Green ash	Alberta Saskatchewan Manitoba	Medium population levels in many urban plantings and shelterbelts throughout central and southern Alberta; also in localized areas near Lac du Bonnet and McArther Falls in Manitoba and in Swift Current, Regina, and Moose Jaw in Saskatchewan.
Aspen and poplar leaf and twig blight *Venturia macularis* (Fr.) E. Müller & Arx *Venturia populina* (Vuill.) Fabric.	Aspen Poplar	Alberta Saskatchewan	Various degrees of infection evident on regeneration in both provinces.
Aspen serpentine leafminer *Phyllocnistis populiella* Cham.	Aspen	Alberta Saskatchewan NWT	In Alberta and Saskatchewan, light mining evident in most aspen stands. Light to moderate mining in the Camsell Bend area, NWT.
Aspen webworms *Tetralopha aplastella* (Hulst) *Meroptera pravella* (Grt.)	Aspen	Saskatchewan	Low to medium populations in forest tent caterpillar and large aspen tortrix infestation areas. Especially common in Meadow Lake Provincial Park.
Atropellis canker *Atropellis piniphila* (Weir) Lohman & Cash	Lodgepole pine	Alberta Saskatchewan	Infections in pine stands in Waterton Lakes National Park, Cypress Hills Provincial Park, along the Trunk Road between Nordegg and the Clearwater Ranger Station, and at several locations in Kananaskis Country.
Birch leaf miners *Fenusa pusilla* (Lep.) *Profenusa thomsoni* (Konow)	Birch species	Alberta Saskatchewan Manitoba	Light, moderate, and severe infestations very common on planted birches in urban areas. Severe mining persisted in some native birch stands examined in Alberta and Saskatchewan. In Manitoba moderate injury reported in The Pas area.
Black-knot of cherry *Apiosporina morbosa* (Schw.) Arx	May Day tree Choke cherry	Alberta Saskatchewan	Notable infection levels reported on May Day trees in many urban centers. Commonly found on choke cherry in native stands.
Boxelder twig borer *Proteoteras willingana* (Kft.)	Manitoba maple	Alberta Saskatchewan	Shoot damage on both shelterbelt and urban plantings in many areas.
Bronze birch borer *Agrilus anxius* Gory	Birch species	Alberta Saskatchewan	Generally associated with birch dieback on urban plantings. Samples received from Edmonton, Red Deer, Calgary, Lethbridge,

Northwest Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
			and Saskatoon. Reports of borer damage showed a definite increase in many areas.
Bruce spanworm *Operophtera bruceata* (Hulst)	Aspen	Alberta Manitoba	Pockets of light to moderate defoliation in the Calgary, Stettler, Drumheller, and Obed areas in Alberta. In Manitoba, moderate injury reported in the Duck Mountain area.
Chemical injury from pesticides	Many hosts	Alberta Saskatchewan	Improper application of these agents is continuing to be an ever-increasing problem in many areas of the region.
Clearwing moth *Synanthedon* sp.	Spruce Pine	British Columbia Alberta Saskatchewan	Stem and branch mortality is increasing on mature and overmature trees in urban centers and also in some native forest stands. Especially common in some localized areas in Kootenay, Banff, and Jasper national parks.
Cottonwood leafmining beetle *Zeugophora scutellaris* Suffr.	Poplar	Alberta Saskatchewan	Light damage reported on hybrid poplars in several areas of southern Alberta. Also on plantings on University of Saskatchewan grounds.
Cytospora canker *Cytospora chrysosperma* (Pers.) Fr.	Poplar Mountain-ash	Alberta	Light infection levels common in native stands in most areas that were checked. Especially evident in Whistlers Campground in Jasper National Park. Very common on mountain-ash plantings in urban centers where this species has been predisposed to infection by winter injury.
Douglas-fir beetle *Dendroctonus pseudotsugae* Hopk.	Douglas-fir	British Columbia Alberta	Low populations persist in Jasper National Park near Annette and Patricia lakes and between Jasper townsite and the west gate. Residual populations evident in the Redstreak Campground area in Kootenay National Park.
Early aspen leafroller *Pseudexentera oregonana* Wlshm.	Aspen	Alberta Saskatchewan Manitoba	Light, moderate, and severe leaf rolling in aspen stands between Calgary and Turner Valley and in the Camrose, Hardisty, Red Deer, Lacombe, and Stettler areas in Alberta. In Saskatchewan, light to moderate injury occurred between Macdowell and Rosthern, from Langham to Radisson, near Maymont, and in the west and center blocks of Cypress Hills Provincial Park. In Manitoba, light and moderate injury reported near Sprague and in the Duck Mountains.
Eastern blackheaded budworm *Acleris variana* (Fern.)	Spruce	Alberta Saskatchewan Manitoba	Light defoliation evident at several locations in Alberta and Saskatchewan. Moderate injury reported on mature spruce in Riding Mountain National Park, Manitoba.
European alder leafminer *Fenusa dohrnii* (Tischb.)	Alder	British Columbia Alberta	Light to moderate infestations common in Yoho and Jasper national parks. Some mining noted in Waterton Lakes National Park.

Northwest Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Fall cankerworm *Alsophila pometaria* (Harr.)	Elm Green ash Manitoba maple	Alberta Saskatchewan Manitoba	Continues to cause varying degrees of defoliation in urban areas such as Lethbridge, Medicine Hat, Swift Current, Regina, Brandon, and Winnipeg.
Fire blight *Erwinia amylovora* (Burr.) Winsl. et al.	Apple Mountain-ash	Alberta	Few reports of infections received, indicating a probable decline in 1988.
Flooding	Many species	NWT Alberta	Extensive flood damage reported in the south Great Slave Lake area and along the Liard River Valley in the NWT. As a result of high precipitation and expanding beaver populations, significant losses in commercial forests evident in the Footner Lake Forest in Alberta.
Gall wasp on oak *Callirhytis* nr. *flavipes* (Gill.)	Bur oak	Alberta	A definite increase in reports received from areas where oak is used for urban plantings. Twig and leaf galls are becoming more prevalent in some urban areas such as Edmonton, Calgary, and Red Deer.
Gray willow leaf beetle *Tricholochmaea decora* (Say)	Willow species	British Columbia Alberta Saskatchewan	Significant skeletonizing injury to willow foliage evident in Yoho National Park and in the Fort McMurray, Slave Lake, Peace River, and Edson areas in Alberta. In Saskatchewan, low population levels evident throughout the forested areas.
Greenheaded sawfly *Pikonema dimmockii* (Cress.)	Spruce	NWT	Light to moderate spruce defoliation reported in the Alexandra and Louise Falls campground areas.
Honeysuckle aphid *Hyadaphis tataricae* (Ajzen.)	Spruce	Alberta Saskatchewan	Becoming an ever-increasing problem on most honeysuckle species. Causes rosetting and a brooming effect on the foliage of terminal shoots.
Hypoxylon canker *Hypoxylon mammatum* (Wahl.) Miller	Aspen	Alberta Saskatchewan Manitoba	No change from previous seasons. Infections generally common in aspen areas of the region.
Jack pine sawfly *Neodiprion virginianus* complex	Jack pine Lodgepole pine	Alberta Saskatchewan	Low population levels persist in the Chip Lake-Edson area of Alberta and in some areas within the Nesbit Forest in Saskatchewan.
Larch sawfly *Pristiphora erichsonii* (Htg.)	Larch	Prairie provinces NWT	Moderate to severe defoliation in several areas in the Northwest Territories. Light defoliation in a few small areas in Alberta. Populations endemic in other areas.
Large aspen tortrix *Choristoneura conflictana* (Wlk.)	Aspen	Prairie provinces	Moderate to severe defoliation reported over 2849 ha of aspen in western Manitoba. Scattered pockets of moderate to severe defoliation in Saskatchewan. Light to moderate defoliation in small areas in southern Alberta.

Northwest Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Leaf beetles *Chrysomela* spp.	Aspen Poplar Willow	British Columbia Alberta Saskatchewan	Light, moderate, and severe skeletonizing of poplar and willow very evident in Banff, Jasper, Yoho, Kootenay, and Waterton Lakes national parks. Low population levels reported in Cypress Hills Provincial Park in Saskatchewan.
Leaf gall of aspen *Aceria* nr. *dispar* (Nal.)	Aspen	Alberta	Moderate to severe infestations common in central part of province; especially notable in Elk Island National Park and in Cross Lake and Whitney Lakes provincial parks.
Leaf rust *Melampsora medusae* Thuem.	Aspen Poplar	Alberta Saskatchewan	High incidence of rust infections evident in native aspen stands in many areas of central and northern Alberta. In Saskatchewan reported in the Pasquia and Porcupine Hills and in the Glaslyn and Meadow Lake Provincial Park areas. Low and medium infection levels evident on both hosts in Waterton Lakes, Banff, and Jasper national parks.
Linden looper *Erannis tiliaria* (Harr.)	Birch Hazel Manitoba maple Aspen	Alberta Manitoba	Moderate to severe defoliation evident in Manitoba in Turtle Mountain Provincial Park and in Riding Mountain National Park. In Alberta, low populations noted near Drumheller, Medicine Hat, Lethbridge, and Calgary.
Lodgepole needleminer *Coleotechnites starki* (Free.)	Lodgepole pine	Alberta Saskatchewan	In Alberta, medium to high population levels of early-instar larvae evident in Banff National Park between Saskatchewan Crossing and the Weeping Wall area. Low populations collected on Mt. Norquay and in Banff townsite. In Saskatchewan, light mining of needles evident in some pine areas of Cypress Hills Provincial Park.
Lodgepole pine beetle *Dendroctonus murrayanae* Hopk.	Lodgepole pine Jack pine	Alberta Saskatchewan Manitoba	This species of bark beetle was collected in Banff and Jasper national parks, near Blue Ridge, and on jack pine in the Pine Ridge Forest Nursery near Smoky Lake. Low population levels observed in Cypress Hills Provincial Park in Saskatchewan. In Manitoba, collections made near Thompson.
Lodgepole terminal weevil *Pissodes terminalis* Hopping	Jack pine Lodgepole pine	Alberta Saskatchewan Manitoba	Light incidence commonly found throughout.
Needle rust of fir *Pucciniastrum epilobii* Otth	Fir	Alberta	In Waterton Lakes National Park severe injury to young regeneration fir evident along the Cameron Lake Road. Light injury common on fir in several other areas of the Park.
Nelson's juniper rust *Gymnosporangium nelsonii* Arth.	Juniper Saskatoon	British Columbia Alberta Saskatchewan	Fairly high incidence of this rust reported in the following areas: Canmore, Kananaskis Country, Hinton, North Battleford, in Redstreak Campground in Kootenay National Park, near Johnston Canyon in Banff National Park, near Field in Yoho National Park, and

Northwest Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
			between Jasper and the east gate in Jasper National Park.
Northern pitch twig moth *Petrova albicapitana* (Bsk.)	Lodgepole pine Jack pine	Alberta Saskatchewan Manitoba NWT	Light damage to natural regeneration stands and in some plantation sites in the region.
Northern tent caterpillar *Malacosoma californicum pluviale* (Dyar)	Poplar Willow Pin cherry	Alberta NWT	Light, moderate, and severe defoliation reported from several areas in Alberta. In the NWT, several colonies reported on willow in Norman Wells.
Pear sawfly *Caliroa cerasi* (L.)	Mountain-ash Cotoneaster Hawthorn Plum	Alberta Saskatchewan	Moderate to severe defoliation of hawthorn reported in Fort McMurray and High Level. Elsewhere a general decline evident throughout areas inspected.
Pine needle casts *Elytroderma deformans* (Weir) Darker *Lophodermella concolor* (Dearn.) Darker *Davisomycella ampla* (Davis) Darker	Jack pine Lodgepole pine	Alberta Saskatchewan Manitoba	Low incidences of infections of *E. deformans* and *L. concolor* found in pine stands throughout most of the foothills area in Alberta and in the Rocky Mountain national parks. In Saskatchewan, *L. concolor* was reported in the west block of Cypress Hills Provincial Park. *D. ampla* was reported in some pine plantation sites in Manitoba.
Pine needle rust *Coleosporium asterum* (Dietz) Syd.	Lodgepole pine Jack pine	Alberta Saskatchewan Manitoba	Light to moderate infections common in lodgepole pine stands in many areas of the foothills and national parks regions in Alberta. Reported in jack pine stands and plantation sites in Saskatchewan and Manitoba.
Pine needle scale *Chionaspis pinifolae* (Fitch)	Spruce Pine	Alberta Saskatchewan Manitoba	Medium and high population levels in Alberta in most of the forested area inspected. In Saskatchewan, low-to-medium populations in old Forestry Canada plantation sites near Mortlach and Borden and in some areas in Cypress Hills Provincial Park. In Manitoba, low populations in the Gypsumville area.
Pinewood nematode *Bursaphelenchus xylophilus* (Steiner & Buhrer) Nickle	Balsam fir	Alberta	Confirmed specimens taken from dying balsam fir in Sir Winston Churchill Provincial Park near Lac La Biche. No other reports received in 1988.
Poplar borer *Saperda calcarata* Say	Aspen Balsam poplar	Alberta Saskatchewan NWT	Larval activity common in native aspen stands in many areas in both provinces and is becoming an ever-increasing problem in agricultural sites that are encroaching on to native aspen stands. Infested trees found in riverside balsam poplar stands in some areas of the NWT.
Poplar leafminer *Phyllonorycter* nr. *salicifoliella* (Chambers)	Aspen	British Columbia Alberta Saskatchewan Manitoba	Common occurrence in Yoho, Kootenay, Jasper, and Riding Mountain national parks, Duck Mountain Provincial Park, and the Northwest Angle Provincial Forest. Present in varying degrees in most forested areas inspected.

Northwest Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Porcupine	Lodgepole pine Jack pine Scots pine	Alberta Manitoba	Porcupine feeding was responsible for considerable top-kill in pine stands in many areas of the national parks in Alberta. In Manitoba, damage reported on Scots pine in the Spruce Woods area and in some jack pine plantation sites southeast of Winnipeg.
Septoria canker *Mycosphaerella populicola* G.E. Thompson	Poplar	Alberta NWT	Canker infections on branches and stems commonly found in hybrid shelterbelts and in plantations in the central part of Alberta. In the NWT, medium to high infection levels reported along the Liard River in the vicinity of Fort Liard.
Shot-hole of cherry *Coccomyces hiemalis* Higgins	Choke cherry	Alberta	Shot-hole injury very common on urban plantings in many areas of the province.
Silverleaf *Chondrostereum purpureum* (Pers.: Fr.) Pouzar	Cotoneaster Mountain-ash Nanking cherry Plum	Alberta	A slight increase in infection levels in 1988.
Snowshoe hare	Lodgepole pine Jack pine	Alberta	Light and moderate injury reported on both tree species in many areas of northern Alberta.
Spittlebug *Aphrophora* sp.	Jack pine	Manitoba	Low populations in Whiteshell Provincial Park.
Spruce bud midge *Rhabdophaga swainei* Felt	Spruce	Alberta Saskatchewan NWT	Rosetting common in some regeneration areas inspected.
Spruce gall adelgids *Adelges* spp. *Pineus* spp.	Spruce Douglas-fir Lodgepole pine	Alberta Saskatchewan NWT	Common where most of the host trees appear. Especially notable on urban plantings.
Spruce needle cast *Lirula macrospora* (Htg.) Darker	Spruce	British Columbia Alberta	Low to medium infections in several areas of the Alberta foothills and in Kananaskis Country. Light infection levels in Waterton, Yoho, Banff, and Jasper national parks.
Spruce needle rust *Chrysomyxa* spp.	Spruce	Alberta Saskatchewan NWT	Medium to high infection levels in many areas of northern Alberta and in the NWT. Similar infection levels in native spruce stands in the Big River-St. Walburg areas in Saskatchewan. Low infection levels in the Rocky Mountain national parks.
Spruce spider mite *Oligonychus ununguis* (Jac.)	Spruce Juniper Cedar	Alberta Saskatchewan	Continues to be a major problem in urban plantings and in some farm shelterbelts.
Squirrel	Lodgepole pine Jack pine	Alberta Manitoba	Branch flagging injury common in the Rocky Mountain national parks. In Manitoba, reports of injury received from the Jenpeg and Suwannee River areas.

Northwest Region, cont.

Insects, Disease, or Damage	Host(s)	Location	Remarks
Stalactiform blister rust *Cronartium coleosporioides* Arth.	Lodgepole pine Jack pine	Alberta Manitoba	Infections common on lodgepole pine in the following areas: Saskatchewan Crossing in Banff National Park, Athabasca Falls in Jasper National Park, along the Cameron Lake Road in Waterton Lakes National Park, and in Kananaskis Country. Infections in jack pine plantation sites in Manitoba.
Two-year-cycle spruce budworm *Choristoneura biennis* Free.	Spruce	British Columbia	Light damage in the Numa Creek area of Kootenay National Park and near Emerald Lake in Yoho National Park.
Uglynest caterpillar *Archips cerasivorana* (Fitch)	Choke cherry	Alberta Saskatchewan Manitoba	Tents common in southern Alberta near Macdowall and the Battlefords in Saskatchewan, and in the Spruce Woods area in Manitoba.
Western ash bark beetle *Hylesinus californicus* (Swaine)	Green ash	Alberta Saskatchewan	Causing considerable branch mortality in the following areas: Calgary, Medicine Hat, Lethbridge, and Drumheller in Alberta. In Saskatchewan, light infestations reported in Saskatoon, Regina, and Swift Current.
Western gall rust *Endocronartium harknessii* (J.P. Moore) Y. Hirat.	Lodgepole pine Jack pine Scots pine	Alberta Saskatchewan Manitoba NWT	Stem and branch galls common in many areas. New infections reported on Scots pine in Alberta.
White pine weevil *Pissodes strobi* (Peck)	Spruce Jack pine	Alberta Saskatchewan Manitoba	An increase in reports of injury from many areas in the region. Becoming more prevalent in plantation sites and on urban plantings. Light injury in the Rocky Mountain national parks.
Willow leafminer *Micrurapteryx salicifoliella* (Cham.)	Willow	Alberta Saskatchewan NWT	Varying degrees of injury along the Slave and Liard rivers in the NWT and along many watercourses throughout northern Alberta. Light injury was common on the host species in central and northern Saskatchewan.
Wind	Several species	Alberta Saskatchewan Manitoba	Blowdown of trees as a result of tornados and very high winds reported in the Gimli, Pine Falls, and Winnipeg areas of Manitoba. In Saskatchewan, blowdown evident in a jack pine plantation site in Cypress Hills Provincial Park. In Alberta, some blowdown was evident in aspen stands in Kananaskis Country and in Waterton Lakes National Park.
Yellow headed spruce sawfly *Pikonema alaskensis* (Roh.)	Spruce	Prairie provinces NWT	Moderate to severe damage common in several small areas. Light defoliation in a few areas in the Northwest Territories.
Yellow witches' broom *Chrysomyxa arctostaphyli* Diet.	Spruce	Alberta Saskatchewan	Becoming very common in mature stands of spruce in several areas of both provinces.

Selected Bibliography

The following list includes reports and publications produced in 1988 by the staff of Forestry Canada. Copies may be obtained from the originating forestry centre.

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